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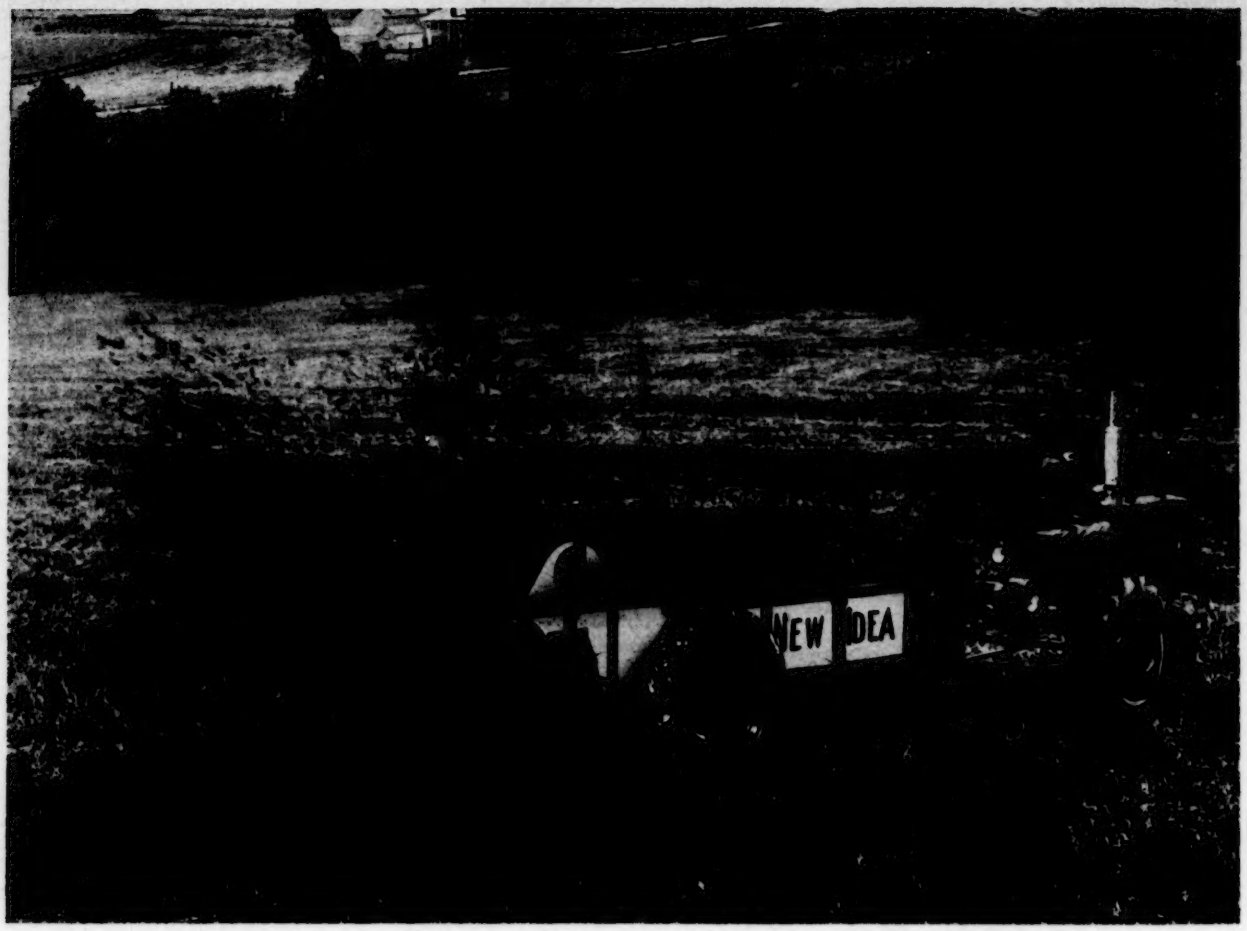

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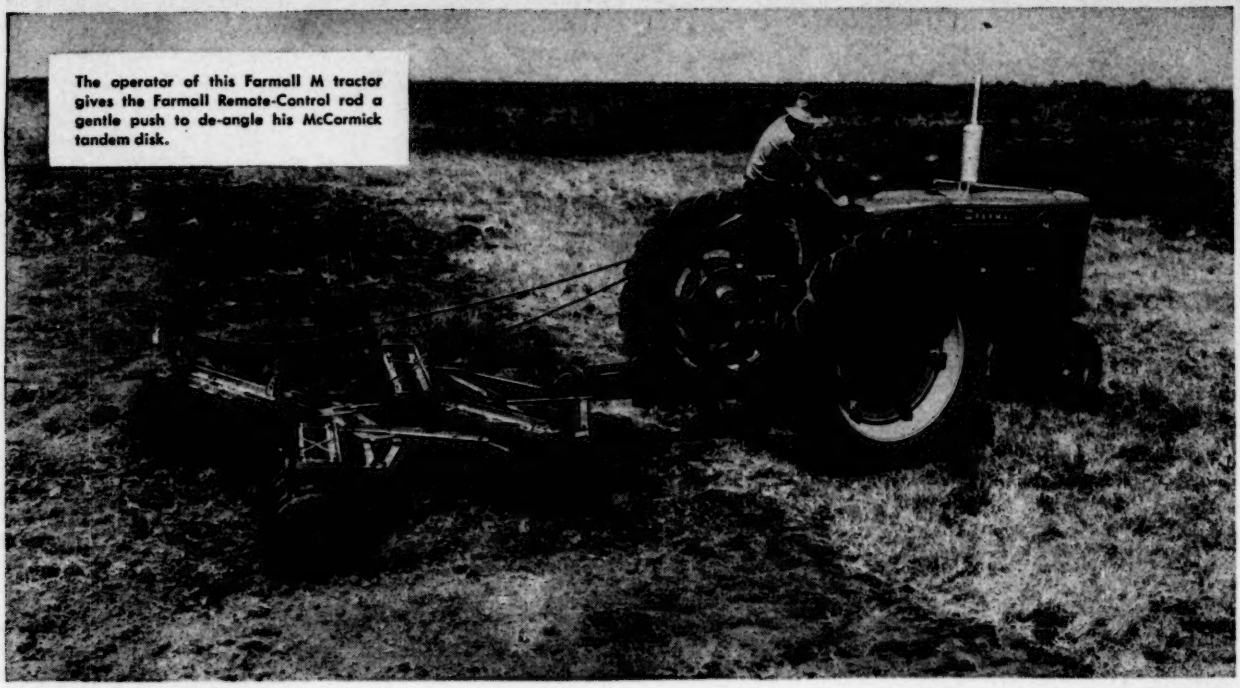

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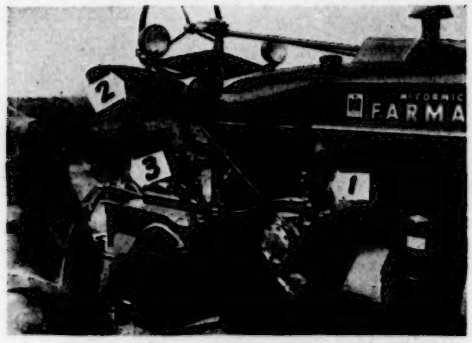

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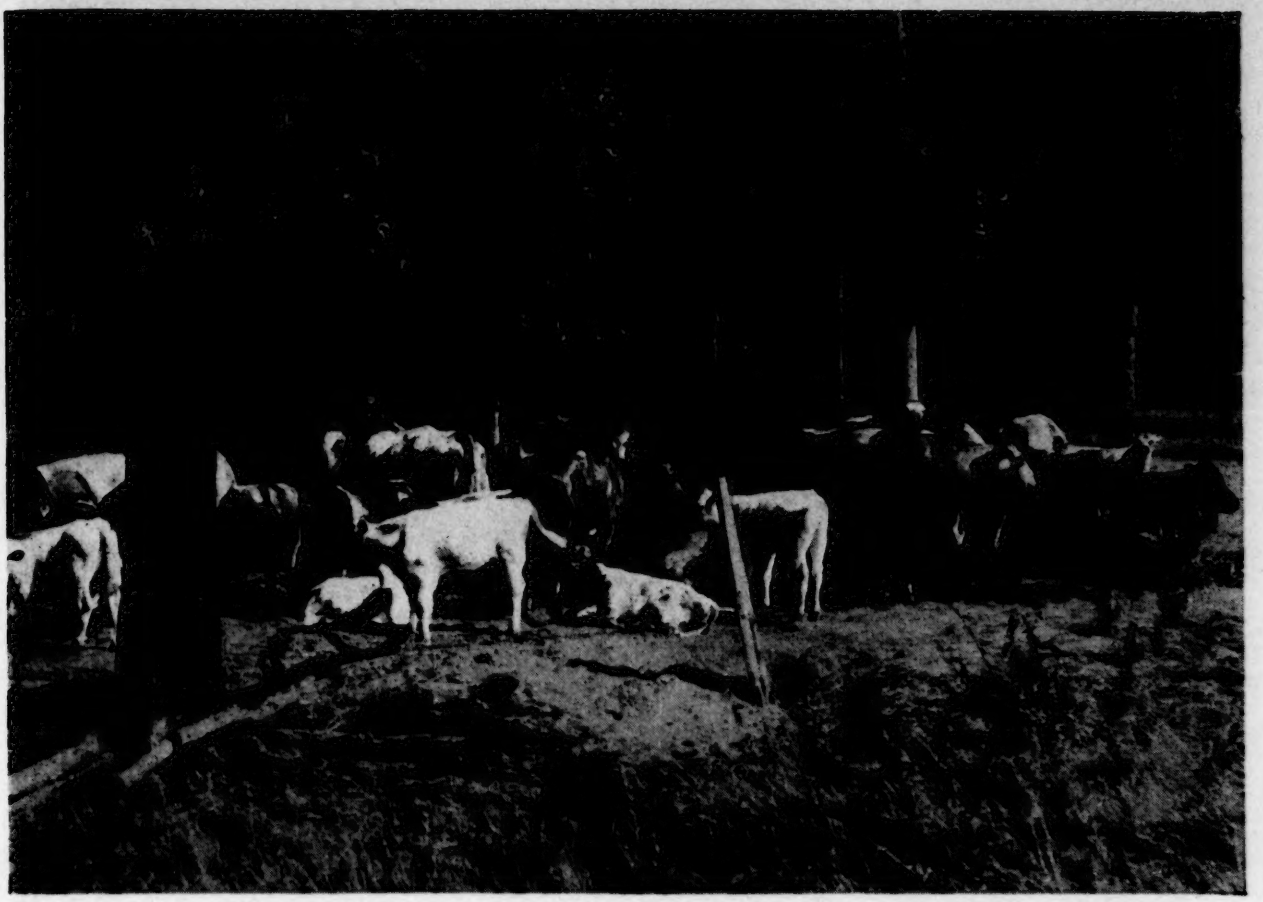

A romantic scene of ruinous farming

There are few sights more beautiful than a herd or flock patiently munching grass in a grove of trees or in the woodlot.

But there are few farm practices more damaging.

The constant stomping of animals, pounds down and compresses the natural mulch of decaying vegetation. Instead of acting as a sponge to hold moisture and raise the water table of the surrounding land, it permits rainfall to run off.

Moreover, in the eating of the grass, livestock also eat the sprouting young trees that Nature plants to replace the mature timber that can be harvested each year as a cash crop.

Conservation is a lot of things. It is putting land to best usage... marginal land in timber... other land in grass and pasture... the best land in field crops. It is contouring and strip cropping the slopes... slowing down fast moving streams... building ponds for holding water for irrigation, livestock, and recreation.

In short, conservation is taking the long view instead of the short one... putting agriculture on a permanently profitable basis for our sons and their sons as well as for ourselves.

Too much good land has already been plundered. Conserving what is left is a needed job for all... for us who build farm machinery, for the farmer who uses it, for you who are guide and confidant to America's 6,000,000 farmers.

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VOLUME 5
NUMBER 1

Journal of SOIL AND WATER CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SOCIETY OF AMERICA

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Farmers can eat their cake

...and have it, too!

Yes, modern conservation practices soon begin to repay their cost—enable farmers to eat their cake and have it, too. Controlling erosion helps to hold productive topsoil on the land and, accordingly, hoists crop yields.

Contouring, terracing, strip-cropping, and other soil-saving operations, which can be practiced with regular farm equipment, mend mismanaged or erosion-scarred land. Grasses and legumes, together with agricultural limestone, green-manure crops, commercial fertilizers, and barnyard manure, rebuild soil productivity. This double-barreled program enables soil conservation farmers to maintain their land and increase crop yields.

Soil conservation, however, is more than a remedy for ailing acres or a recipe for bigger profits. It's a gilt-edged investment in America. By making our agriculture more stable and productive, modern soil conservation practices help to maintain our economic well-being and safeguard our national security.

JOHN DEERE MOLINE, ILL.

From the Editor—

Yale University recently announced the establishment of a new graduate program of research and instruction in the conservation of natural resources. It is being undertaken in cooperation with the Conservation Foundation of New York. Dr. Paul B. Sears, now at Oberlin College, will be in charge of the work as Professor of Conservation. The program calls for considerable field research in the Connecticut River Valley.

Fred A. Wirt, a member of the Soil Conservation Society of America Council and advertising manager for the J. I. Case Company, Racine, Wisconsin, has been honored by the Freedoms Foundation at Valley Forge, Pennsylvania, in recognition of his contribution to the American way of life by "speaking up for freedom." The recognition is based on a brochure of chart form, "Which Road America?" It traces America's progress from the Declaration of Independence, Constitution and Bill of Rights, and it warns of three roads ahead—the American highway of individual freedom, loss of liberty, such as in socialistic Great Britain or the dictatorship of Communistic Russia. Mr. Wirt received $1,500 and a medal for his effort in making this important contribution.

"Toward an Appraisal of World Resources" by Gilbert F. White, President of Haverford College, is the title of a very fine paper published in Volume 29, Number 4 of the GEOGRAPHIC REVIEW. Dr. White brings a new point of view to many of our conservation problems thereby adding much to which we already know. He discusses "Population and Food Supply," "Advancing Technology of Resource Use," "Conservation Economics and Politics," "Unity in Land—Unity in Administration," and "Conservation Education." Additional information regarding this paper may be obtained by writing to the American Geographical Society, Broadway at 156th Street, New York.

The United States Edition of *"Food and People"*—a UNESCO project in cooperation with FAO—is now available. It embraces six booklets and a discussion guide and may be obtained for $1.65 by writing to the Manhattan Publishing Company, 225 Lafayette Street, New York 12. Orders may also be placed for single copies as noted below. This important subject is now being discussed throughout the world and covers the following in pamphlet form: *Food and the Family* by Margaret Mead, Anthropologist, Columbia University, 25c; *UN Sets the Table* by Peter Kihss, New York Herald-Tribune reporter, 25c; *Food and Social Progress* by Audre Mayer, a leading Nutritionist of France, 25c; *Distribution of the World's Food* by Stephen Krolekowski, Secretary of the Polish National FAO Committee, 25c; *Are There Too Many People?* by Alva Myrdal, wife of the well-known Swedish Sociologist and Paul Vincent, noted French Professor of Demography, 50c and *Food, Soil and People* by Charles E. Kellog, Chief, Bureau of Plant Industry, Soils and Agricultural Engineering, 60c. Darel McConkey is editor of the series.

Early last year the Milwaukee Chapter of the Soil Conservation Society of America adopted what is believed to be the first soil conservation creed. Since then it has appeared in numerous magazines and publications. The creed puts into words what a soil conservationist is and what he stands for and was written by C. W. Gee. Copies suitable for framing may be obtained for 25c by writing to J. C. Burton, Chapter Treasurer, care of the Nitragin Company, 3747 North Booth Street, Milwaukee, Wisconsin.

This issue of the *Journal* contains eleven pages of advertising representing twelve separate industries. This investment in space for advertising purposes means much to the Society and also helps to further extend the conservation movement. It is hoped that when members write to advertisers that they mention the *Journal*. Many of the advertisements, in addition to selling their product, also tell a factual story that relates the need for conservation to our economic and social structures. The *Journal* needs more advertising to help support and further extend conservation in all its phases.

Orchids to the NEW YORK STATE CONSERVATIONIST for the many fine articles covering all phases of conservation that appear regularly. The last two issues contained in outline form, an excellent "conservation primer." Another article of interest is entitled "Cold Weather Conservation." This publication and others issued elsewhere are contributing much to the development of an effective and well-rounded conservation program. Another subject of interest is a new book *"TVA and the Grass Roots"* by Philip Selznick. It is a study of the TVA organization, its doctrine and its policy in action.

The Contribution of Crop-Use Research

CARL F. SPEH

Dr. Carl F. Speh points out in this paper that "The Conventional function of agriculture as the supplier of food and fiber for man's nourishment and protection seems gradually to be broadening. Recent advances in the science of chemistry and in the application of industrial technology are making agriculture important also as a provider of raw materials for many industrial products. Our mineral resources, particularly petroleum, which now supply a preponderant share of these raw materials, may not be depended upon to supply them indefinitely in the quantities needed. In other words, it looks as if our soil resources may in the future be called upon to serve us in a greater variety of ways than they have in the past."

IN THIS DISCUSSION of whether our present approach to the conservation job is adequate, I want to talk mainly about just one phase of that job—*the efficient and economical use of farm products.*

It might be argued that the question of how farm products are used has nothing much to do with soil conservation as we ordinarily think of it. Perhaps that is true. But on the other hand I think we can agree that finding better ways to utilize agricultural commodities is important for achieving the broader aims of soil conservation. And I believe it is important also in any consideration of future world food supplies, conservation of mineral and forest resources, and related questions that may well concern us here.

The approach to crop-utilization problems taken by the Bureau of Agricultural and Industrial Chemistry is through chemical and engineering research. As many of you know, the object of the Bureau's work is to develop new and extended uses for farm products—both as foods and feeds and as industrial raw materials. But how, exactly, is this research related to conservation?

I presume it is correct to say that our purpose in conserving land and forest and water resources is to maintain their productivity or usefulness—in terms of crops, timber, wildlife, and water power—so that they may serve man's needs and contribute to his enjoyment of life. The ultimate usefulness of soil resources depends, however, not only on the crops they can continue to produce, but also on what we are able to do with those crops. That of course is where research on crop uses comes in. Its purpose is simply to help us get the highest possible return from what the farmer grows, to eliminate some of the waste in crop production, and generally to make the soil and water resources we have serve us more effectively.

Extending the Uses of Farm Products

The production of all crops requires a certain expenditure of natural and human resources. We have learned a great deal in recent years about how to cultivate the soil and harvest its fruits in greater yield, with less effort on the part of the farmer and without making the land unfit for future cultivation. We have found that, under certain conditions and with the proper farming practices, and with improved varieties of plants and breeds of animals, it is possible to increase substantially the "*productive potential*" of the land. A great deal of research toward this end is of course going on. But that is not the whole job.

The useful value of farm products, like the productive capacity of the land, is not necessarily fixed and beyond hope of improvement. In fact, it appears that we are only beginning to reap the harvests of industrially valuable materials that the soil can produce—or is already producing, if we can only recognize and use them.

In our research attack on the problems of crop utilization we are attempting to advance on several fronts at the same time. The Bureau of Agricultural and Industrial Chemistry is of course just one of many organizations that are carrying this work forward. Other agencies of the Federal Government and organizations supported by the States and by industry are also engaged in crop-use research. The work of my own Bureau, which is particularly broad in scope, is carried on in our four large Regional Research Laboratories and at a number of smaller field stations in various parts of the country. This research effort may be divided into four main categories.

Phases of Crop-Use Research

First of all, we are working to improve and extend many of the *conventional uses* for farm products as foods and fibers. Methods for processing and preserving fruits and vegetables are being improved, so that larger markets can be developed for these perishable commodi-

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Carl F. Speh is Assistant Chief, Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture, Washington, D. C. Mr. Speh presented this paper on a panel—Are We Taking an Adequate Approach to the Conservation Job?—along with three others at the Annual Meeting of the SCSA held in St. Louis, November 10-12, 1949.

dies throughout the year in all sections of the country. We are pursuing extensive investigations on the utilization of corn, wheat, and other grains to provide improved foods, feeds, and raw materials for industry, including starches, sugars, proteins, industrial alcohol, and other products. A large proportion of the work at our Southern Regional Research Laboratory at New Orleans is devoted to the improvement of cotton textile processes, equipment, and products, with the aim of extending the uses for cotton. We are doing research on the storage and processing of oil seeds and their products, and on the production of turpentine, rosin, and other substances from pine gum.

Secondly, we are investigating practical ways to use *agricultural wastes and residues* of various kinds—for example, wheat straw, corncobs, waste vegetable leaves, and the pulps and juices from fruit canneries. Most of these waste products, which accumulate in large quantities on farms and at processing plants, now have little or no value and in many cases are a nuisance to dispose of. But the farmer has to grow them along with the more readily marketable portion of his crops, using his machinery and fertilizer and enlisting the aid of sun and rain and soil to do so.

A *third* phase of our research is the development of new uses for the *chemical constituents* of agricultural commodities and better methods of obtaining them in usable form and economical quantities. Many substances available in the products of the soil are needed increasingly by industry, which employs them—often in obscure ways—to make a great variety of useful things. Included in this category of our work is the development of new compounds using starches and sugars, and new products from plant and animal proteins. We are studying the isolation of antibiotics from plants and means of producing antibiotics by fermentation methods in which agricultural byproducts play a part. Exploring possible domestic sources of tanning materials and of natural rubber are other projects in this category.

Finally, we are conducting an intensive program of *fundamental research* the results of which contribute to the solution of many practical problems that arise in the other fields of work I have mentioned. This program includes fundamental investigations of the chemistry of fats and oils, proteins, starches, sugars, and cellulose; studies of the allergenic and pharmacological properties of various crop constituents; studies of the behavior of enzymes; and other basic work in biochemistry, microbiology, and related fields.

These four categories—the expansion of conventional uses for farm products, development of uses for agricultural wastes and byproducts, discovery of new industrial uses for the chemical constituents of agricultural materials, and necessary fundamental investigations—give you a general outline of the Bureau's research effort. I might mention very briefly a few specific advances that have been made recently as a result of this work.

Food Industrial Benefit from Research

I am sure you are familiar with frozen concentrated orange juice, a new food product that has had phenomenal success during the last few years. About 10 million gallons of this frozen orange-juice concentrate was produced in the 1948-49 crop year, and output during the current season is expected to reach a total of 20 million gallons in Florida alone—equivalent to something like 30 percent of that State's orange crop. This product was developed through cooperative research by the Florida Citrus Commission, the citrus industry of the State, and the Bureau's laboratory at Winter Haven, Fla. It has made a significant contribution to expanded markets for oranges—first in Florida and now also in California—and has provided a practical means of utilizing many oranges that are unsuitable for marketing as fresh fruits.

Another important development in the field of citrus processing has been made at the Bureau's laboratory in Pasadena, Calif. This is a method for producing frozen orange and lemon purees. They are now being sold to bakeries, ice-cream and sherbet manufacturers, and other food processors throughout the country. Frozen purees from many fruits other than citrus have been on the market for a number of years, but products of this kind were not made from oranges and lemons because of a belief that they would develop a bitter taste. The Bureau found, however, that citrus purees properly prepared would not turn bitter. The present commercial products retain the full natural flavor and nutritive quality of the fresh fruit. If stored at 0 degrees F. they will keep for more than a year with little or no loss of flavor, color, or vitamin C. The large-scale production of these frozen orange and lemon purees, confined so far to one plant in California, is virtually just beginning. It appears likely that the process for making them will soon be introduced in other citrus-producing areas, particularly in Florida.

The Bureau's Western Regional Research Laboratory at Albany, Calif., has developed a new method of food preservation called "dehydrofreezing" which has promising possibilities. It involves partial dehydration of fruits and vegetables to reduce their weight and bulk by about half, followed by conventional freezing. The potential economic advantage of the process over ordinary freezing is in the lower cost of packaging, transporting, and storing the final products, made possible because of their reduced weight and bulk. This method has been adapted successfully on a pilot-plant scale to green peas, sliced apples, and apricots, and preliminary work has

been done on peaches and a few other commodities.

A number of other advances in research on food preservation might be mentioned. The Western Regional Laboratory, for instance, is investigating the possibilities of precooked frozen foods of various kinds, particularly those made with poultry meat and with vegetables such as potatoes that cannot be frozen uncooked. At the Eastern Regional Research Laboratory in Philadelphia we have developed a method for recovering and concentrating the volatile flavor essences of apples and other fruits. These essences can be added to various fruit products to restore the flavor ordinarily lost in processing.

Utilization of Crop Wastes and Residues

The second category of crop-use research I mentioned was finding uses for agricultural wastes and residues. We might first consider the waste involved in producing vegetables. On the truck farms of this country we grow something like 7 or 8 million tons a year of a dozen of our most important vegetable crops. This is the total tonnage of these crops, including not only marketable vegetables but also the leaves, vines, pods, stalks, and other materials that have practically no market value at present, in spite of the fact that many of them are rich in proteins, minerals, vitamins, and other food elements. The fact is that less than half our vegetable production actually reaches the consumer in the form of vegetables —fresh, canned, frozen, or made into various food products. The rest of this vegetable tonnage—some four or five million tons a year of leaves, vines, etc., produced by the farmer's labor, by sunlight and water, and by the soil itself—simply goes to waste.

The production of many other crops is similarly wasteful—we have millions of tons of unused wheat straw, cornstalks, and corncobs, for example. By and large only about half the agricultural materials which man and nature cooperate to produce finds worthwhile use today. Surely this must be regarded as agricultural inefficiency. It means that we are not making complete use of our soil and water resources from an agricultural standpoint.

If science and industry could find ways to exploit these agricultural wastes and residues—the discarded vegetable leaves, the wheat straw and corncobs, the waste pulp and juices from packing-house operations—it would result in much greater returns than we are now getting from our present expenditure of human and natural resources in crop production.

As a result of work by the Bureau of Agricultural and Industrial Chemistry and by other research organizations, considerable progress is in fact being made toword economical utilization of these wastes. Methods developed at the Eastern Regional Loboratory are being used by a number of companies to dry waste vegetable leaves to provide high-protein feed meals for livestock, particularly poultry. Industrial research has led recently to the use of a considerable quantity of corncobs for the production of furfural, employed in making an intermediate chemical necessary for the maunfacture of nylon. Furfural has been produced for some years from oat hulls and cottonseed hulls for use in petroleum refining and in production of wood resin and synthetic resins. The Bureau's Northern Regional Research Laboratory at Peoria, Ill., developed a method of using ground corncobs successfully as a soft-grit material for air-blast cleaning and polishing of machine parts, foundry molds, and glass. Various other residues, including nut shells, have been ground by the Laboratory and used as extenders for plastics.

Perhaps the most notable recent contribution in the field of residue utilization by the Peoria laboratory has been improved processes for making pulp for building board and paper products from wheat straw. These developments are likely to have an important impact on the entire pulp and paper industry—and indirectly on the conservation of our forest resources. Considerable work has been done also on the utilization of waste fruit and vegetable juices in fermentation processes for the production of industrial alcohol, feed yeast, and other products, including new antibiotics. As you may know, large quantities of corn steep liquor, a byproduct of the corn-refining industry, are now used in the production of penicillin as a result of wartime research at the Bureau's Northern Laboratory. The field of fermentation, which we are only beginning to exploit, is one that offers very wide possibilities for the more complete utilization of farm commodities.

Industry Looks to Research for New Products

The third category of crop-use research I mentioned was the finding of industrial uses for chemical constituents of farm products. *As the advocates of "chemurgy" point out, farm products are reproducible—a new crop can be grown every year or so. But the products of our mines and oil wells, on the other hand, are not reproducible—once used, they are virtually gone forever. For this reason it may well be that substitution of chemicals from farm-grown materials for those obtained now chiefly from our organic mineral resources will play an increasingly important role in resource conservation.* The fact is, of course, that a number of organic chemical compounds now usually derived from petroleum, coal, and natural gas can also be obtained from agricultural sources. Also, the remarkable developments of recent years in the substitution of plastics for metals vividly illustrates one phase of the possibilities in this field.

Examples of new uses for farm products as sources of industrial raw materials are numerous, and I would like to mention two or three from the field of synthetic-rubber production. The most common type of synthetic rubber

manufactured at present, called GR-S, utilizes butadiene, a chemical derived from ethyl alcohol. The alcohol itself can be produced synthetically from byproduct cracking gases obtained in the manufacture of gasoline from petroleum, or it can be produced from grain or other starchy crops by fermentation. At the moment most of it is made from petroleum cracking gases. Some types of synthetic rubber utilize another chemical, isoprene, which can also be produced from either petroleum or agricultural sources. The Bureau's Naval Stores Research Division has developed a method for producing isoprene from gum turpentine, and also a process for the manufacture of a new type of synthetic rubber made with isoprene that is superior in some respects to our GR-S rubber.

More recently, the Naval Stores Research Division has collaborated with the Office of Rubber Reserve in research on the use of various terpene peroxides as catalysts in the production of the new "cold rubber." Some of these peroxides, which utilize the terpene constituents of pine gum, have proved to be efficient catalysts. The peroxide used most extensively in cold-rubber production at present is obtained from petroleum. Development of suitable terpene peroxides would not only provide a substantial market for turpentine components, but would also make available a renewable source of these highly strategic materials, and thus help to relieve demands upon the petroleum industry in cases of national emergency.

Substances obtained from agricultural sources can be used also, of course, in many ways other than as replacements for petroleum and other mineral products. One of the most useful and versatile classes of agricultural substances is the proteins. They are used in foods and in livestock feeds, and also in a variety of industrial products. Thus we have paints and plastics from casein, a protein of milk, and adhesives of various kinds from animal proteins and soybeans. Leather is largely a protein product.

Research Possibilities in Crop Utilization Great

The Bureau has done considerable research on the conversion of various proteins to fibers. We have found means of making fibers from casein, from zein (a protein of corn), from both peanut and cottonseed protein, and from keratin (a protein of chicken feathers, found also in animal hair, hooves, and horns). Casein fiber, for automobile carburetor air filters, furniture stuffing, and stiff cloth used in suit lapels, and zein fiber, which has many of the properties of wool, are both now in commercial production, largely as a result of research at the Northern and Eastern Regional Laboratories.

Another plentiful farm-grown material that has wide industrial use is starch. One recent development of the Eastern Laboratory's research on the utilization of starchy crops is "allyl starch," a compound that has aroused considerable industrial interest because of its outstanding properties as a base material for protective coatings, printing inks, linoleum, and other plastic compositions. The Laboratory has also developed a method for conversion of the starch in whole potatoes to lactic acid. This process involves enzymatic conversion of the starch to sugars and simultaneous fermentation of these sugars to produce lactic acid. The carbohydrate, protein, mineral, and other constituents of the whole potatoes provide sufficient nutrients to support the growth of microorganisms in the fermentation process. Lactic acid is an important chemical in the tanning, food, textile, pharmaceutical, and other industries.

The developments I have cited are just a few among many, but I believe they will give you some idea of the trend in production and use of industrial chemicals from things the farmer grows. Considered from the scientific standpoint, the possibilities in this great field of crop utilization are just beginning to be explored.

In our brief discussion of some of the recent achievements that have been made in finding new and wider uses for farm products, I have given no examples of the fourth category of research in this field—that is, the fundamental investigations of the chemical structure and properties of various farm-grown materials. There is not time for that here, but I would like to say that this basic research is indispensable to the success of applied research from the long-term viewpoint. Unless we can open the doors to new scientific knowledge through fundamental studies, our practical or applied research sooner or later finds itself up against a blank wall, lacking the facts necessary for further progress.

Drain on Soil and Water Resources May Be Greater

As I said at the beginning, it may be questionable whether the uses we make of agricultural commodities have much to do directly with soil and water conservation as ordinarily considered. *However, we may be able to agree that they affect our conservation efforts indirectly. The thought I would like to leave with you is this: The conventional function of agriculture as the supplier of food and fiber for man's nourishment and protection seems gradually to be broadening. Recent advances in the science of chemistry and in the application of industrial technology are making agriculture important also as a provider of raw materials for many industrial products. Our mineral resources, particularly petroleum, which now supply a preponderant share of these raw materials, may not be depended upon to supply them indefinitely in the quantities needed. In other words, it looks as if our soil and water resources may in the future be called upon to serve us in a greater variety of ways than they have in the past.*

(*Continued on page* 41)

A Survey of the Minor-Element Situation

FIRMAN E. BEAR

Early during 1949, Lloyd E. Partain—then President of the Soil Conservation Society of America—appointed Dr. Firman E. Bear Chairman of a special Committee to survey the minor-element situation. This paper is a report of that Committee and was presented at the Annual Meeting of the SCSA at the St. Louis Meeting, November 10-12, 1949. It is published in full because of the unusual interest shown by members of the Society and others in the growing importance of minor-elements throughout the country.—EDITOR

ONE OF OUR LARGEST FARMER COOPERATIVES is now adding two grams cobalt sulfate to every ton of its dairy-cow feed. It is putting iodized salt and manganese sulfate in all its poultry feeds. And five pounds of borax are mixed into every ton of its fertilizer.

A large mineral-feed industry has been developed for providing mineral supplements for livestock feeds. A number of physicians are recommending mineral tablets containing iodine, magnesium, copper, and zinc as curatives for certain types of ill health in man. In many areas, boron, magnesium, manganese, zinc, and copper are being put into fertilizers or applied to plants in spray form.

These practices indicate a strong suspicion of widespread deficiencies of minor elements in soils, plants, animals, and man. Recently molybdenum has been added to the list of elements that are necessary for plants. It thus becomes the fifteenth element to be assigned a definite role in plant nutrition. So far as is known, molybdenum and boron are not required by animals, including man. Similarly cobalt, fluorine, and iodine are required by animals but not by plants.

No doubt other elements will be found to be essential to plants or animals, or both, in time. Recently nine samples of alfalfa from six states were analyzed for 35 minor elements. All these samples contained all the elements mentioned above, and aluminum, chromium, nickel, and strontium as well. Of the remaining members of the list, only vanadium and silver were found, and these only in the alfalfa from the New Jersey Agricultural Experiment Station Farm.

In general, the need for minor elements is greatest on the sandy coastal plain soils along the Atlantic Ocean and the Gulf of Mexico. But soils far removed from the coast are often found to be deficient in one or another of these elements, or in several of them. Thus zinc deficiency is quite common in the irrigated soils of California; boron deficiency in legumes is widespread throughout the humid regions of the United States; a large belt of iodine-deficiency for man and animals is found south and west of the Great Lakes; copper has been shown to be essential to the production of crop plants on peat soils, and cobalt-deficiency areas for livestock are widely distributed from Michigan to New Hampshire and Florida.

Minor Elements Needed as Production Goes Up

New areas of minor-element deficiency are constantly being located. Need for these elements for plants is being increased as acre yields are stepped up by using heavier applications of liming materials and fertilizers and by growing higher-yielding hybrids. These higher yields increase the requirements for the minor elements that are needed by plants and dilute the plants' content of those minor elements that are needed only by animals. Similarly, the stepping-up of milk production per cow requires that larger amounts of the minor elements that are essential to animals be contained in the feed. This is necessary not only for the cow herself but for her progeny and for all other consumers of her milk.

Since freight costs are highly important items in the delivered price of fertilizers, the tendency has been toward an ever greater purification of fertilizer materials so as to increase their percentage content of nitrogen, phosphorus, and potassium. As a result, a large part of the impurities found in the natural salt or rock deposits has been eliminated. Minor elements constitute a portion of all such impurities. The best example of such purification is found in the potash salts that are being used in the manufacture of fertilizers. There was a time when potassium could be bought in the form of kainit, which contained only 12.5 per cent potash and large percentages of a considerable variety of other elements. Modern muriate of potash contains 99 per cent KCl, leaving little room for anything else. Likewise Chilean nitrate has been greatly purified in order to raise its nitrogen content to that of the synthetic product.

The popularity of animal manures can be explained in large part by the great variety of both major and minor plant-nutrient elements they contain. Feedstuffs often come from areas of production that are far removed from the farm on which they are fed. Thus the manure that is produced on a New Jersey farm contains elements that have been collected from the soils of the corn, grain-sorghum, wheat, and cotton belts as well as from those of the home farm.

Compost piles, about which so much is being written in the garden literature of today, contain parts of plants

from the four corners of the earth. Thus the refuse of coffee from Brazil, bananas from Honduras, pineapples from Hawaii, apples from Oregon, oranges from California, grapefruit from the Rio Grande Valley, vegetables from New Jersey, and refuse from trees, shrubs, flowers, and grass from the home garden all go into the compost pile.

When all the facts are known, of which those related to minor elements are an important part, it should be possible to take all the mystery out of the manure pile. Once this mystery is resolved, inorganic manures of greatly improved quality can be produced. They will have the advantage over animal manures and composts in that they can be reproduced at will.

The soils department of the New Jersey Agricultural Experiment Station is carrying on intensive studies of cobalt, copper, iodine, manganese, molybdenum, and zinc. Studies are also being made of magnesium, sodium, and chlorine. A large amount of work has been done with boron and fluorine. Use is being made of radioisotopes of calcium, sodium, and zinc. Field tests have been made of radioactive ores. Special attention is being paid to air contamination.

Minor Element Research Program Is Broad in Scope

The agricultural experiment stations of 18 states and of Hawaii and Puerto Rico now have 28 minor-element research projects in effect. Florida, Georgia, Idaho, Massachusetts, New Jersey, Ohio, South Carolina, and Texas specifically mention boron. Hawaii and Texas list cobalt. Florida and Texas mention copper. Manganese is included in the list for Florida, New Jersey, Ohio, and Puerto Rico. Zinc is listed in Florida, Hawaii, New York, Ohio, and Texas. Alabama mentions only magnesium. California, Indiana, Louisiana, Missouri, New Hampshire, South Dakota, Utah, and Virginia do not list the specific elements in their minor-element project titles. Probably all 18 states are studying more than one minor element, either in relation to their content in the soil, their requirement by plants, or their function in animals.

Similarly, the Bureaus of Plant Industry, Animal Industry, Agricultural and Industrial Chemistry, and Entomology and Plant Quarantine of the U.S.D.A., and the U.S. Plant, Soils, and Nutrition Laboratory at Ithaca, New York, list 41 minor-element research projects. Boron, zinc, copper, magnesium, manganese, iron, sodium, and sulfur are specifically mentioned in plant studies, and cobalt, copper, iron, manganese, zinc, molybdenum, and lead in relation to animals.

A considerable number of universities, other than those associated with the agricultural experiment stations, are making fundamental studies of the functions of minor elements in living cells. For example, Johns Hopkins University recently received a grant of $500,000 for this purpose. Many industrial laboratories are investigating these elements from the point of view of including them in insecticides, fungicides, feeds, fertilizers, and liming materials. Producers of pharmaceuticals are no doubt carrying on studies with minor elements as constituents of medicines.

It is apparent from this discussion that a great many people are concerned with one or another phase of the minor-element problem. The most complete picture of the undertakings in this field to date is contained in a 1087-page volume entitled *Bibliography of the Literature on Minor Elements and Their Relation to Plant and Animal Nutrition, Fourth Edition,* published by the Chilean Nitrate Educational Bureau in 1948. This contains abstracts of some 10,000 papers that had been published as of that date. These abstracts cover researches on 45 elements.

Of the more recent books on minor elements, the following merit special mention:

Corrie, Frank E. *Some Elements of Plants and Animals.* Fertilizer Journal Ltd. London, 1948.

Gilbert, Frank A. *Mineral Nutrition of Plants and Animals.* University of Oklahoma Press, Norman, 1948.

Monier-Williams, G. W. *Trace Elements in Food.* John Wiley and Sons, Inc., New York, 1949.

Scharrer, Karl. *Biochemic der Spurenelemente.* Edwards Brothers, Inc., Ann Arbor, Michigan, 1943.

Stiles, Walter. *Trace Elements in Plants and Animals.* The Macmillan Company, New York, 1946.

A Water Cost of Runoff Control

A. R. CROFT

Studies in Utah show that deep rooted aspen trees take more water from the soil than shallow rooted herbaceous plants. Cutting aspen trees and leaving only herbaceous plants increased the amount of water available for streamflow. The herbaceous cover thus far has been equal to aspen in preventing erosion. This suggests that replacement of deep rooted plants by shallow rooted ones may be a means of increasing streamflow. More research is needed however to make certain that such plant cover changes can be made without increasing the hazard of excessive summer storm runoff because the primary objective of watershed management throughout the west is to keep soils stable and prevent damaging floods.

WATER THAT SUSTAINS CIVILIZATION in the arid valleys of the West comes from distant mountains that receive two or three times as much precipitation annually as the valleys. Some minimum level of plant cover is necessary on these steep mountain lands (Figure 1) to control runoff and keep soil stable. The vegetation that does this consumes water that might otherwise reach the valleys as stream flow or as ground water. A necessary goal, in watershed management, therefore, is to get the maximum possible yield of water from the mountains by management of the plant cover without thinning it so much as to produce destructive summer floods. This problem is being studied by the Intermountain Forest and Range Experiment Station on the water-yielding lands near the top of the Wasatch Mountains in Utah.

Normal stream flow from these mountains is characterized by a rapid rise in spring and a gradual recession to low flow in late summer. Most of the runoff is derived from snow that accumulates on the mountains during the winter months and melts during a period of six to eight weeks in the spring. Virtually all of the melted snow water reaches stream channels by percolating through a wet soil and rock mantle. Water that reaches streams in this manner is called seepage flow runoff. We have learned something about the conditions necessary for producing this kind of runoff from studies of watershed mantles to depths of six feet within which most of the roots of trees, grasses, and leafy plants are located.

In the spring after free water from melted snow has drained away, we have found that this six-foot soil and mineral mantle contains about 18 inches of water, or about three inches of water per foot of mantle depth. This soil moisture condition, usually called field capacity, represents the amount of water the soil can hold in capillary form against the pull of gravity. None of this water is available for stream flow.

A. R. Croft, Forester, Intermountain Forest and Range Experiment Station, U. S. Department of Agriculture, Ogden, Utah, describes recent experiments on the effect of removal of aspen stands on water yield. These studies are part of a program of watershed research conducted by the Intermountain Station.

Evapo-Transpiration Deficit Related to Stream Flow

By fall the processes of evaporation and transpiration reduce soil moisture from 18 inches to about six inches, which appears to be the water content at the wilting percentage. The difference between the 18 inches as held at field capacity and the six inches still retained in the mantle at the end of the growing season constitutes a 12-inch deficit in soil moisture due to evapo-transpiration. It is therefore called the evapo-transpiration deficit. This deficit must be overcome before free water can again pass through the mantle for stream flow.

Plants also use water from summer rains which vary from five to ten inches per summer in storms that seldom exceed an inch. These rains fall on relatively dry soil and each increment of moisture is soon lost by evaporation and transpiration. Although the rains provide some moisture for sustaining plant growth, they are not sufficient to overcome the evapo-transpiration deficit, so that water can again pass through the soil and contribute to stream flow.

Since the soil moisture deficit is overcome each spring, plants always start growth with the same amount of

Figure 1. A north-facing watershed in Farmington drainage showing steep slopes and plant cover typical of the experimental area. Water consumed by vegetation that controls surface runoff and keeps soil stable on these lands is a necessary cost of maintaining desirable watershed conditions. In the West there are millions of acres of such water yielding lands.

available water stored in the soil, even though water in the snow pack may be greatly below normal. Stream flow, however, varies with the amount of precipitation. For example, from a snow pack containing 50 inches of water 38 inches would be available for stream flow after the normal 12-inch deficit in the soil is satisfied. When the snow pack contains only 20 inches of water, retention of 12 inches by the mantle would leave only eight inches available for stream flow.

Mountain lands yield the great bulk of their runoff as seepage flow although they can also produce violent discharges of overland flow, especially during high-intensity summer rains. These rains cause no overland flow where dense undisturbed vegetation occurs. On the other hand, where vegetation is greatly thinned or the ground is bared, as much as 40 to 60 percent of the rain may run off the surface. This type of runoff erodes the soil. It can cut deep channels and produce devastating mud-rock floods. These, of course, must be prevented.

Three Plant Cover Condition Areas Were Studied

The vegetal requirements for controlling rainstorm runoff have been studied on some tree-covered sites in the water yielding zone (Figure 2). These sites are occupied by a stand of aspen trees whose light leafy crowns permit a dense understory of herbaceous plants. The vegetatiton on these sites has prevented overland flow and all soil loss during 15 years of record.

In 1947, two other plant cover conditions were created on a series of study plots: (1) all aspen trees were removed leaving only the grasses and leafy plants; and (2) all vegetation was removed. During the past three years almost as effective control was afforded by the herbaceous vegetation alone after the aspen had been removed. However, these areas have not experienced rains as intense as before aspen was removed.

Removal of all vegetation unleashed the extremely high surface runoff potential that characterizes these lands. From plots in this denuded condition the amount of overland flow in one summer was only 0.68 inch or about ten percent of the summer total. Nevertheless, this small amount eroded soil at the alarming rate of ten tons per acre. Obviously, watershed conditions that produce such extravagant soil losses are intolerable.

The cost of these three conditions, for controlling runoff as measured by the amount of water consumed, was also investigated. The method of determining water consumption was the indirect one of studying moisture content in blocks of soil 80 feet long, 30 feet wide, and six feet deep (Figure 3). The moisture content of these blocks at field capacity, minus the moisture content at the end of the growing season was used as a measure of the evapo-transpiration deficit created by the respective cover conditions.

The evapo-transpiration deficits produced by these three conditions for three years averaged about 11 inches on sites with aspen trees and herbaceous cover, about eight inches for herbaceous plants alone, and about three inches on bare ground.

Removal of the aspen trees thus saved about three inches of water. Removal of all vegetation saved about eight inches. The 3-inch saving of water by removing aspen is believed to be conservative because the trees consumed some water that could not be measured by the methods used. This unmeasured use occurs during a 4- to 6-week period of spring snow melt during which catkins are developed and early leaf growth frequently

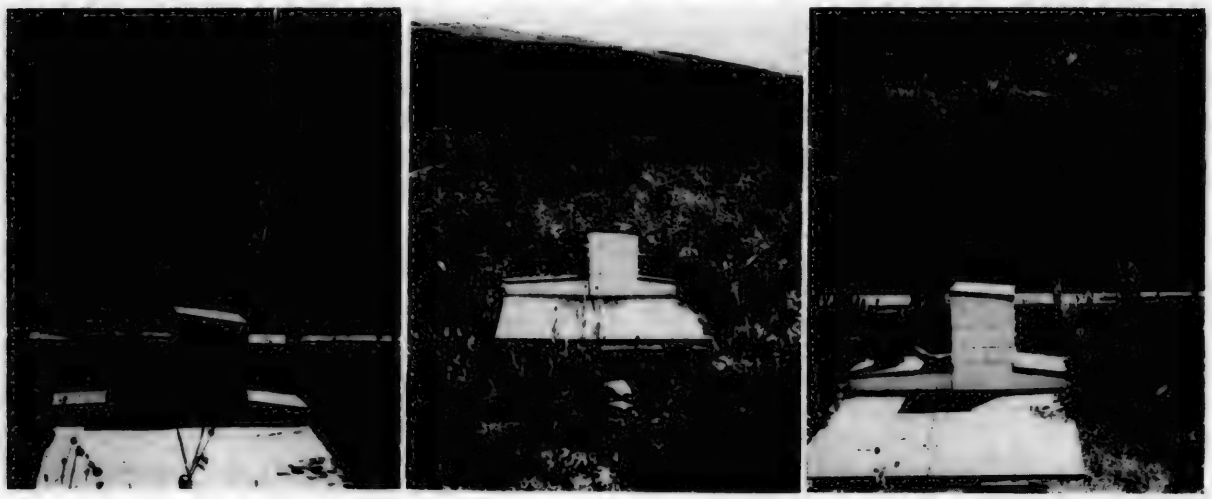


Figure 2.—Typical plant cover conditions on plots where evapo-transpiration and runoff control studies were made, near Farmington, Utah. Left to right: Aspen trees with understory of herbaceous plants; herbaceous plants after removal of aspen; and no vegetation.

occurs. The amount of this additional use has been estimated at about one inch. Therefore, four inches is considered to be a closer approximation of the water consumed by the aspen-herbaceous vegetation over that consumed by the herbaceous vegetation alone.

Removal of Deep Rooted Trees Conserves Water

The reason water is saved by the removal of aspen is found in the distribution of its roots with respect to roots of herbaceous plants. The tree roots penetrate the soil to a depth of six feet or more. This is two to three feet deeper than herbaceous roots extend. Thus, three or four inches more water is available to aspen roots than to herbaceous roots. This additional available water probably accounts for the fact that the trees grow vigorously for about a month longer in the fall than herbaceous vegetation. The latter begins drying as early as August 1, presumably because it has used all the moisture available to its roots.

Although removal of the deep rooted trees conserves water for stream flow, further thinning of the stand by removal of some of the herbaceous plants would probably not have the same effect. Since the herbaceous plants begin to dry up about August 1 for lack of water, additional water made available to fewer plants would merely result in lengthening their growing season. Eventually, however, the soil would dry out as much as with the unthinned stand. Theoretically, therefore, thinning should not result in any increase in water available for stream flow.

Water saving by altering plant cover probably can be achieved only when deep-rooted species are removed, or are replaced by more shallow-rooted plants.

The eight-inch evapo-transpiration deficit due to herbaceous vegetation appears to be the minimum water cost of keeping sufficient vegetation on the ground for summer flood control. The fact that both trees and herbaceous cover now appear about equal in controlling this type of runoff, suggests that the greater quantity of water used by the aspen type over the herbaceous type does not provide additional runoff control.

The four inches of water saved by removing aspen trees is equivalent to about 200 acre feet per square mile of watershed. If this saving appeared as stream flow most of it would come during the period of high spring flow but some, no doubt, would contribute also to very valuable summer stream flow.

The saving of water by cutting aspen could have different effects on water yield in different years. For example, when runoff from a given area is 24 inches, a four-inch saving might represent as much as one-sixth of the yield for the area treated, but in a year when runoff is only ten inches a four-inch saving might represent as much as 40 percent of the yield.

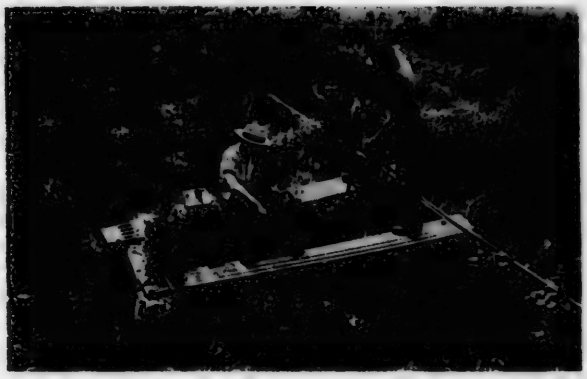


Figure 3. Sampling the soil for moisture content on a herbaceous plot. With this long tube called a geotome 4,000 soil samples were taken during three summers on 10 experimental plots.

This exploratory study suggests that removal of aspen may be a feasible means of getting increased stream flow in the area studied. It also suggests that removal of any deep rooted plants may be effective in reducing evapotranspiration losses and in making more water available for stream flow. However, much more research is needed to determine the practicability of this approach in this locality and on the wide variety of other climatic, topographic, soil, and plant cover conditions that exist elsewhere in the West.

Water is so scarce in the arid valleys of the West that in some localities we may be justified in manipulating the plant cover to increase stream flow. It cannot be emphasized too much, however, that the primary objective of watershed management always must be to keep soil stable and prevent destructive runoff and sedimentation as far as possible. Increasing water yields is a desirable objective only where it can be achieved without causing damaging runoff and sedimentation.

Since technology is based upon the mining of resources and since its progress spells the progressive pillage of the earth, it is obvious that in a state of perfection it will practice the most complete and the most intensive exploitation on a planetary scale, a mining of all its resources in the most rational manner. This sapping and mining is bound to produce losses which must become increasingly unbearable. The devastations of this pillage are not limited to the exhaustion of mines, of oil wells and other resources. Neither this nor the reckless exhaustion of the topsoil which spreads erosion and the sinking of water tables will be decisive in themselves, although—in America, for instance—these warning signals are already looming big.

—FRIEDRICH G. JUENGER

Conservation Education In The Public Schools

ELLEN HARTNETT

GREAT MOMENTS IN HISTORY are not always set down by historians. They are more likely to be the times when people are doing something about a situation and talking very little about it. For years the educators from the various agencies in Washington, from our colleges over the country, and our public schools have joined hands with the manufacturers of farm equipment, the nurseries, the fertilizer companies, cement industry, and any others who felt they had a contribution to make, in the promotion of this program of programs—Soil Conservation! No one has been looking for personal gain or glory; but each one is trying to find a way to solve this problem that means so much to all Americans.

When I began teaching in the one-room school, the county superintendent of schools honored us with an unexpected call. We were not following the regular schedule as set up, but we were busy discussing a problem of erosion that had been the chief topic since a recent flood had washed out a bridge near the school. This had caused the children to walk a longer distance to school. That was an important problem. It had ruined several fields. To us these issues were more important than the three R's. I was called in for a conference shortly afterward to discuss my procedure. However the county superintendent was understanding and she said she didn't object to me teaching these so-called frills if I promised not to neglect the important required subjects. She feared I would omit something important. Of course I must admit I promised and followed the curriculum as I knew I should after the conference; but I must also admit that I smuggled in some English themes about soils and some geography lessons about saving our rich heritages of nature. The boys and girls loved it. They wanted to know about the world in which they lived. They hold the key to all learning if we educators would only remember this. It is that secret word called *desire*. The great leader of progressive education, John Dewey once said, "He who creates a desire to learn in a child does more than he who forces him to learn."

Schools Have Been Side Stepping Real Issues

Too many educators have in the past been setting up a curriculum for children and telling them here it is, these are the things you must know, "come and get it" and then they have stood in front of the room like a dictator and dared the child to think. I am sorry to say we still have some of this ridiculous type of teaching going on in some of our public schools and also in some of our colleges. Schools have been reticent to change from old pathways. After all, the public pays the way and they timidly view new planning and wonder will the public like it. Dare we change? And the taxpayer watches the public school with eagle eyes and says, We didn't do it that way when I went to school. How dare they use our money this way! Such fads! Such frills! What won't they do next. Now when I went to school—. Now does Mr. Public use such reasoning when he sends for a doctor? Does he say, send me a good old fashioned doctor. I want my appendix removed. Now doctor, please use the method you used when you removed grandmother's appendix 25 years ago! No indeed, Mr. Public does not say anything of the kind, but rather he says, Is there a new up-to-date method? A painless way? A time saver? One that will get me back to work in a few days.

I recount these incidents only for one reason—for many years we have been tiptoeing around and side stepping important issues.

At a meeting of the Izaak Walton League of America in April 1944, five years ago, Dean Thomas Eliot Benner, Dean of the College of Education, University of Illinois, addressed the group. I recently re-read his address. He called the attention of the group that—The child lives 168 hours a week. The school has him for only about 25 hours of that time. In the elementary school, such subjects as reading, writing, spelling, history, geography, art and music will take 80 or 90 per cent of those 25 hours. Other subjects are already competing strenuously for any time which is left. In the high school, English, Mathematics, foreign languages, history and science will again occupy approximately 80 per cent of the student's time. For the remaining 20 per cent, or less, other subjects already in the schools are competing. In addition, we have insistent demands for more physical education, for religious education in school time, and for more vocational education. On top of

This paper, by Miss Ellen Hartnett along with three others, was presented on the panel—How Should We Train the Soil Conservationist—at the Annual SCSA Meeting held in St. Louis, November 10-12, 1949. Miss Hartnett is associated with Iowa State College at Ames, Iowa. She is a pioneer in the Conservation Education Movement and is the author of many conservation articles and papers.

these come requests that children take part in Junior Red Cross activities, scrap drives, bond and stamp sales, etc. In other words, school programs are crowded and new subjects find it extremely difficult to gain a place for themselves.

Educators Are Responsible for Conservation Education

My first point is that conservation will get into the schools—not through the introduction of new subjects, because new subjects are going to have the greatest difficulty in fighting their way into the school program—but through inclusion in subjects already in the school. History is an example of this. Our pioneer period was a period of destruction of wildlife and other resources, the burning of the prairies, the killing off of the buffalo, the wiping out of one species after another, the exploitation of everything that we had, with the general idea that nature was so bountiful it would never run out. Courses in history should include material which bears on conservation.

Geography, dealing with man and his environment, ought to be so modified as to bring in conservation materials. Arithmetic could very well deal with problems taken from the field of conservation as well as problems from other areas. The materials used in teaching children to read or in increasing their proficiency in reading could be materials with conservation background in them, materials which would at the same time educate the child concerning conservation. In the social studies a picture of the social consequences of failure to conserve our resources could be presented. Some understanding of the problems of social organization in a democracy which are involved in getting better protection of resources could be given. And in the sciences we could find ways and means of inculcating a better understanding of the interdependence of human life, animal life, marine life, and the environment. We have not yet done this very successfully.

I suggest first, then, that conservation come into the program of public education not as a new subject but, rather, as modifications of existing subjects. My second suggestion is that conservation come into the program of the public schools through the mediation of educational leaders and not through the other administrative agencies now in the field. This means that the job must be done by educators who know the programs of the schools and the changing interests and abilities of the children in the schools at each grade level.

Conservation came into our schools by a back door. It crept in quietly. Supervisors said teach it if you want to but don't say anything about it.

In 1943 the Department of Rural Education under the leadership of Dr. Howard A. Dawson did a courageous thing. The Department dedicated their yearbook to Conservation Education. Courageous people told how the programs were growing in their areas. The forward of the handbook began like this: **The American people have been blessed by a vast, rich, and beautiful continent. It is theirs to use wisely, to cherish and to hand on to future generations without waste and despoliation. The ideals, knowledge, and skills of the 13,000,000 rural school children of our country will have much to do with what happens to our land and its resources now and in the future. Conservation is a prime obligation of American citizenship.**

This yearbook is for the use of rural teachers and others working in rural education. Its purpose is to present existing phases of conservation education that may prove stimulating to schools and communities desiring to put a functional program of conservation into their own schools. It does not show the status of conservation education in the United States, but it suggests sources where this can be ascertained.

Conservation Education Embraces These Guideposts

These are mere glimpses of beginnings in our conservation programs. Today conservation education is recognized as a necessary part of every good program of education. Some state legislatures have gone so far as to say conservation is a must to be taught. They have written it into the laws and have given it a place of importance. Some state departments are telling their elementary and high school pupils the importance of teaching conservation education. Among the goals are these guideposts

1. To teach the history of natural resource depletion.
2. To destory the ideology of America's inexhaustibility.
3. To teach the interrelation of people, other animals, plants and earth.
4. To present the idea of stewardship of natural resources.
5. To clarify the rights of society as they conflict with the desire of the individual to exploit.
6. To examine the claim that the world market can supply us when our own resources are exhausted.
7. To study the relation of science to conservation.
8. To examine local resources in relation to community living standards.
9. To familiarize pupils with the conservation work being done.
10. To guide the growth of a pupil philosophy of conservation.

(*Continued on page* 22)

Improving Farm Irrigation Practices

WAYNE D. CRIDDLE

IT IS IRONICAL that the life-giving waters brought to arid lands can also be the means of destroying them. Many serious land and water problems confronting irrigated agriculture today are a result of man's misuse of these resources. It is only over the past few years that man has begun to realize the need for better farm irrigation practices throughout the West. Streaks of yellow now appearing in his once black topsoil, alkali accumulations and waterlogging of the lower lands, and decreased yields cause a thinking farmer to stop and take stock of the careless use that has been made of his land and water.

Although irrigation has been practiced for more than 100 years in parts of the West, methods and practices in the use of irrigation water has improved little. In fact, it is probably safe to say that the poorer irrigation practices are found on the older irrigated lands and better practices on the newer lands. Such conditions are believed to exist because of several reasons.

1. Early day irrigation was begun on a small scale where water was plentiful and cheap and when technical assistance was extremely limited.
2. Structures for adequate control of irrigation water on the farm had not been developed.
3. Little or no consciousness of the resulting damage existed. Erosion by irrigation water is not a dramatic thing. Complete ruination doesn't happen over night. Even removing an inch of topsoil each year when accomplished by a number of irrigations with in-between cultivations is not too easy to recognize. Likewise over-irrigation with resultant waterlogging of lower lands and alkali accumulation seems to be hard to recognize at first. Once the water is in the soil and moving underground it is extremely difficult to follow.
4. Lands were plowed up and placed under row crop irrigation that should have been pasture or wood lot.
5. A knowledge of the basic principles governing the flow of water in furrows and across the land was not known nor was the physical and soil moisture relationships understood.

As you all know, irrigation is no longer confined to what has been thought of in the past as the "Arid West." Large irrigation projects are being contemplated and in some cases are actually under construction east of the 100th meridian. Irrigation, particularly by sprinkler, is well established in the eastern and southern states. Conditions are different in each section of the country and the problems encountered when designing an irrigation system for a potato field in Maine may not be the same as those encountered in a potato field in Idaho.

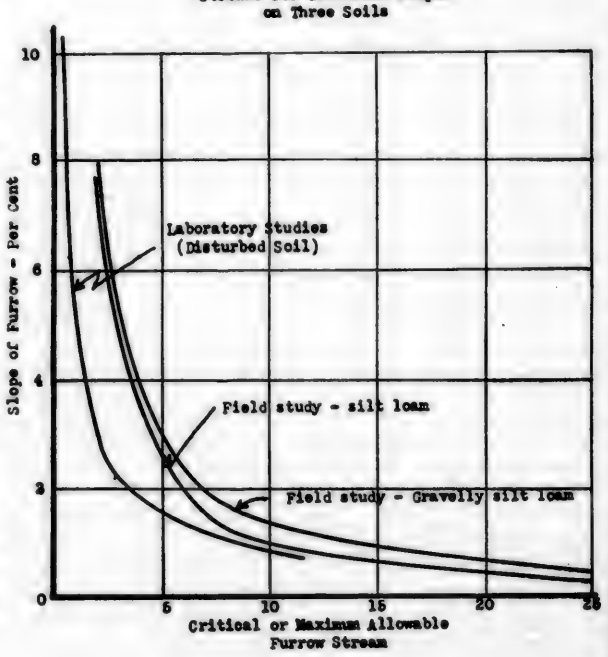
Several of the major problems found in each area might be cited to explain why the soil conservationist must strive to understand the principles of good irrigation and sell them to the farmer.

Irrigation Can Be Destructive

One of the major reasons for destructive irrigation is the change in the erosive power of a stream of water that takes place with a change in slope. In Figure I is shown the critical or maximum allowable furrow stream for different slopes from three studies. Two of the curves were developed by observing the effect of different size furrow streams under actual field conditions. The third curve was developed from results of flume tests with one soil under carefully controlled laboratory conditions. (1)

In each case these curves indicate that on the steeper slopes serious erosion can result with but a small increase

Figure 1. Critical Size Furrow Streams for Different Slopes on Three Soils



Wayne D. Criddle is Project Supervisor for the Soil Conservation Service with headquarters at Boise, Idaho. Mr. Criddle's paper is based on research and application of results of work with farmers and technicians by the Soil Conservation Service. This paper was presented on a panel—Problems of Water Conservation and Control—along with five others at the Annual Meeting of the Soil Conservation Society of America held in St. Louis, November 10-12, 1949.

Figure 2. Determining how much moisture is in the root zone of crop before irrigation. This sample, taken from the three foot depth, indicates that little if any additional water can be stored at this level.

in flow above the critical size stream. If the furrow has a slope less than 1.0 percent adding an additional 5 gallons per minute per furrow may have little or no harmful effect and if the slope is less than 0.5 percent, the addition of 10 or more gallons per minute may be harmless. However, as the slope increases the refinement in control of the furrow stream must be greater. With a 5-percent slope where the critical size furrow stream may be 2.5 g.p.m. a small increase to the stream of 0.5 or 1.0 g.p.m. may cause serious soil movement.

These data emphasize the importance of maintaining flat grades for surface irrigation. If land leveling cannot be used to reduce the slope of the land because of soil depth limitations or for other reasons, then some attempt should be made to plant across the slope just off the contour. Such practices are being recommended in many areas, not only to reduce the erosion but to decrease the time required for an irrigation. The rate at which water enters the soil is much more rapid on the flatter grades and more uniform distribution of water over the land is easier on such grades.

Thus, it can readily be seen why erosion is difficult to prevent on steep lands when irrigated by surface methods. Safe handling of water on the steeper grades requires some refined method of controlling the water. For this purpose, syphons, gated surface pipe, gated wooden flumes, gated spiles, and other devices have been developed but in general, these controls are relatively new. In certain irrigated areas farmers are beginning to use many of these structures. In other areas, there has been little advance in the science of handling irrigation water. In these latter areas it is not uncommon to see as much as 25 tons of soil per acre removed from a field because of a single irrigation. Tests made on one bean field in southern Idaho last year indicated that applying twice the critical stream to a furrow during an irrigation would remove ½ inch of topsoil from the field in one irrigation. Assuming that the beans would require a minimum of four irrigations per year, under the above conditions all of the productive top soil would be gone from that field in four years and heavy yellow unproductive clay would be exposed. If the clay should erode at the same rate, within another 20 years solid laval rock would be exposed over nearly all the field.

Water Holding Capacity of Soils Varies

Another factor that is not fully recognized by most farmers is that the soil is similar to a bucket. It will hold just so much water and any excess that is poured in will just spill out. Amount of water in soil is usually described as so many inches of water per foot depth of soil. The plants cannot take all of this water out of the soil. Sometime before a plant uses all of the soil moisture, it will lose its turgidity and if allowed to go without water for much longer, will reach the permanent wilting point and die. Although the water that a soil will hold and make available for plant use varies considerably between soils, we normally think of the medium-textured soils as holding around two inches of readily available water per foot depth of soil. Heavy soils may hold slightly more and the light soils about one inch.

Thus there is no reason for apply a 12-inch irrigation to a crop having only a 3-foot root zone in a light sandy soil. About 9 inches of that application would just percolate on down through the soil carrying soluable plant food beyond the reach of the plants.

Another point not too well understood by most farmers is the fact that there is a rather definite water requirement point for each crop under a particular site condition. Although alfalfa may use 60 inches of water for satisfactory yields in the Salt River Valley of Arizona, perhaps only 24 may be needed in some of the irrigated valleys of Montana and 35 inches in areas of Kansas. Also, in the latter area, summer precipitation may take care of a large part of this requirement whereas in Arizona, practically all must be supplied by irrigation.

Even though alfalfa may use 60 inches of water in the hot climates, small grains may not need more than 18 inches. Moreover, the requirement by alfalfa and grain is not constant during their respective growing period. The peak daily or weekly use is much above the average for the season.

These and many other problems complicate the conservative use of land and water in irrigated regions. The imposing question confronting those of us working to improve irrigation practices is, *How can we get the irrigation farmer to most rapidly change poor practices for*

those better adapted to his conditions?

As all of us know, it is extremely difficult to get a man to change habits developed over a lifetime. It is particularly difficult to teach a man that each farm or even each field represents a specific set of conditions and that just because his neighbor is sucessfully using one type of irrigation i not necessarily a reason why he should use the same. It would seem that the most effective method of getting better practices might be to each each farmer enough of the basic principles of good irrigation that he will be able to sell himself on the need. Once he is sold on the idea it is usually necessary that he have various technical help available for properly installing the better practices on his farm.

Irrigation Tests Are Helping to Improve Practices

An attempt is being made to improve irrigation practices in many parts of the country by the Soil Conservation Service. Procedures (2) have been developed that are sufficiently accurate but still understandable by the farmer whereby a technician can run a few simple tests on a particular field, analyze the results, and make recommendations for irrigation practices on that particular field. Likewise these tests can be run in front of the farmer and analyzed with his help so that it becomes his recommendation. The tests can be run with single farmers or with neighborhood groups.

Last summer at an irrigation demonstration held near Gooding, Idaho, more than 100 farmers attended. Each participated in the irrigation trials conducted that afternoon. They first checked the amount of moisture already in the soil and estimated (Table 1 and 2) how much water could be stored in the root zone of the crop. (See Figure 2) They then saw different size streams flowing down the furrows on the bean field and the action of the water in these furrows. The smallest stream of about 2 g.p.m. was definitely too small and would never have reached the bottom of the field. The largest stream, 25 g.p.m., rushed through sluicing out all of the loose soil and continuing to cut to the plow-sole. The farmers measured the erosion caused by this large stream and agreed among themselves that by using such practices, nearly all of the top soil would be washed from the field in four years. They then walked across the furrows and observed the action of each of the different size furrow streams and finally after much argument arrived at what they considered the maximum stream that was not causing erosion. They chose a maximum length of run that this largest non-eroding stream would travel and not allow too much soaking and deep percolation at the head of the field but give fairly uniform distribution of water along the furrow. The intake rate of the water into the soil along the furrows was measured and the time that the water should be on the field computed. Before the afternoon was over, each man there knew why recommendations had been made that he cut his irrigation runs in two on his farm, that he reduce the size of the irrigation stream he was using, that he irrigate each set only 6 hours instead of 12, etc.

All of you who have been across the State of Nevada realize the need for water that exists there. The limited available supply should be used just as efficiently as possible. However, a field trial and demonstration conducted in Nevada last summer showed that nearly 75% of the water applied to a grain field was lost by deep

Table 1. Practical Interpretation Chart for Soil Moisture

Percent of RAM Remaining	Feel or Appearance of Soils			
	Coarse	Light	Medium	Heavy and Very Heavy
0	Dry, loose, single grained, flows through fingers	Dry, loose, flows through fingers	Powdery dry, sometimes slightly crusted but easily breaks down into podwery condition	Hard, baked, cracked, sometimes has loose crumbs on surface
50 or less	Still appears to be dry, will not form a ball with pressure*	Still appears to be dry, will not form a ball*	Somewhat crumbly but will hold together from pressure	Somewhat pliable, will ball under pressure*
50 to 75	Same as Coarse Texture under 50 or less	Tends to ball under pressure but seldom will hold together	Forms a ball* somewhat plastic, will sometimes slick slightly with pressure	Forms a ball, will ribbon out between thumb and forefinger
75 to Field Capacity	Tends to stick together slightly, sometimes forms a very weak ball under pressure	Forms weak ball, breaks easily, will not slick	Forms a ball and is very pliable, slicks readily if relatively high in clay	Easily ribbons out between fingers, has a slick feeling
At Field Capacity	Upon squeezing no free water appears on soil but wet outline of ball is left on hand	Same as Coarse	Same as Coarse	Same as Coarse
Above Field Capacity	Free water appears when soil is bounced in hand	Free water will be released with kneading	Can squeeze out free water	Puddles on free water forms on surface.

*Ball is formed by squeezing a handful of soil very firmly with fingers.

Table 2. Form for Determining Water Necessary to Refill the Soil to its Moisture Holding Capacity

1	2	3	4	5	6	7	8	9	10
Depth in feet	Soil texture[1]					RAM[2] holding capacity (Inches)	Soil moisture[3] before irrigation		Moisture storage capacity[4] (Inches)
	V	H	M	L	C		Percent	Depth (Iinches)	
0-1									
1-2									
2-3									
3-4									
4-5									
5-6									
TOTAL									

[1]Check proper space to indicate texture
[2]Readily Available Moisture soil will hold in inches of water per foot depth of soil. Under average conditions, the amounts for the various soils are about as follows:
Very heavy (V)—2.00
Heavy (H)—2.00
Medium (M)—2.00
Light (L)—1.25
Coarse (C)—0.75
[3]Use "Practical Interpretation Chart" for soil moisture determination.
[4]Moisture storage capacity is column 7 minus column 9 or the total readily available moisture holding capacity of the soil minus that already in the soil before the irrigation. This is the amount of water required to bring the moisture up to the water holding capacity of the soil in the root zone.

percolation. The soil was a sandy loam with a fairly rapid intake rate. The test showed that by cutting the length of the runs in two, the field could be irrigated adequately with an average application of four inches instead of the 11 inches per acre per irrigation being used. The other seven inches were merely going to aggravate a bad ground water condition. Basements in the area were wet and crops were being drowned out in the lower areas. By merely revamping the farm irrigation system this farmer could irrigate more than twice as much land with his present water supply. Crop yields may be expected to increase and groundwater conditions will improve with the better practices.

Once this Nevada farmer saw what was happening to his water and land, he readily agreed to revise his system. However, irrigation on this farm was no different than on most others in the community where irrigation has been practiced for more than 80 years.

"Conservation Irrigation" Is Widely Recognized

This problem of educating the farmer in the use of better irrigation practices is important and is recognized by the Soil Conservation Service in its western regions. Mr. J. H. Christ, Pacific Regional Director of the Service, in his annual report for the fiscal year 1948 states:

"A systematic program was inaugurated to give specialized training to all technical personnel working in irrigated areas. In recent years the need for "conservation irrigation" has become widely recognized throughout irrigated sections of the region. Soil erosion from irrigation water is jeopardizing the continued usefulness of thousands of acres of high-cost, high-producing land. Alkali accumulations are similarly threatening large areas of irrigated land. Water shortages, which became critical in several areas during the past year, dramatized the need for irrigation water conservation to meet the growing demand for technical guidance in irrigated sections, the Service held eight training conferences during the year at which technical workers were thoroughly schooled in the latest findings of irrigation research and acquainted with the best known practices for applying irrigation water to the land so as to prevent damage and waste of soil and water resources."

Likewise, the Southwest regional office of the Soil Conservation Service this past summer inaugurated a plan for running irrigation trials and farmer demonstrations. The entire State of Utah was chosen as trial area. Each work group wtihin the state was requested to run at least two irrigation trials in cooperation with farmers. All of the results are to be assembled, analyzed, and used as a basis for future irrigation recommendations. However, it appears to the author, that regardless of how good our information becomes there is still the job of selling it to the farmer and the easiest way to accomplish this is to let him see a test run on his particular farm. Let him make the analyzsis under the guidance of properly trained technicians. Let him say that the length of run is too long, that he has been using streams that are too large or too small, that he hasn't been moving his water often enough, etc. Once we accomplish this the irrigator will make marked improvements in his irrigation practices.

It is only within recent years that we have come to realize the importance of improving irrigation practices in order to save our country's soil and water resources. In thep ast. we have looked with pride at the taller and more massive dams constructed to divert water from

Figure 3. Irrigation without proper control can cause damage. This farmer is resting while the water does its "work."

the streams and at bigger and more efficient conveyance and control structures used in getting the water to the land. Isn't it now about time that we also emphasize the better use of the water on the land? Actual application of water to the land is the basic reason for building these other structures and it is on the land where the damage can be done. To get better use on the land means working with the farmer. Because of the realization of this vital need for conserving our land and water resources by such men as those of you belonging to the Soil Conservation Society of America, the message will reach the ears of the man on the ground. Ways and means for conserving our vital resources will be developed and will be put into practice.

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Conservation Education in Schools

(*Continued from page* 17)

All of these objectives involve a type of teaching that will help pupils to think. Confucious said, *Learning without thought is labor lost; thought without learning is perilous.*

The fascinating story of how man has evicted himself from region after region by destroying his own resources holds student interest today.

We cannot maintain our position as a nation of wealth and benevolent power unless we look on ourselves as a maturing nation and manage our capital resources wisely.

As educators we have been telling the businessman and the taxpayer that, *Education is good business.* Now we have another story to tell and we are doing it rather effectively. We are teaching these young people in our schools to deal with these unscrupulous people who have unmercifully exploited man and natural resources. Through the power of creative thinking the public schools of today are developing individuals capable of making right choices and good judgments on important issues. Today's youth knows that every atom which comes from the earth has meaning and significance to other life. Well prepared teachers have taught these eager pupils that we must feel kindly toward the earth. Today's student looks with skepticism on any plans to upset nature's plans. Why drain that swamp? It may be worth more wet than drained.

Can't you hear today's pupil saying, *We have learned that conservation is the efficient use of resources, and human welfare is its goal.*

Conservation is long range planning. Those who oppose it do not want to know the truth about what lies ahead. Conservation cramps the style of selfish people with exploitive plans. Today's youth looks at the exploiter with skepticism for he knows conservation is the program to maintain proper balance. He knows that he has a part in being a keeper of his brother. Has he not gathered scrap to help win a yar? Hasn't he given up a movie or a sandy bar or an ice cream cone so that he could buy stamps and war bonds? Hasn't he helped gather paper to buy supplies to help his brother across the sea? Doesn't he help pack large boxes monthly to send to a little boy or girl across the sea? Hasn't he read the stories?

I do not worry for tomorrow if we can keep training good teachers who will allow boys and girls to think!

. . . . There can be no talk of riches produced by technology. What really happens is rather a steady, forever growing consumption. It is a ruthless destruction, the like of which the earth has never before seen. A more and more ruthless destruction of resources is the characteristic of our technology. Only by this destruction can it exist and spread. All theories which overlook this fact are lopsided because they disregard the basic conditions which in the modern world govern production and economics.

—FRIEDRICH G. JUENGER

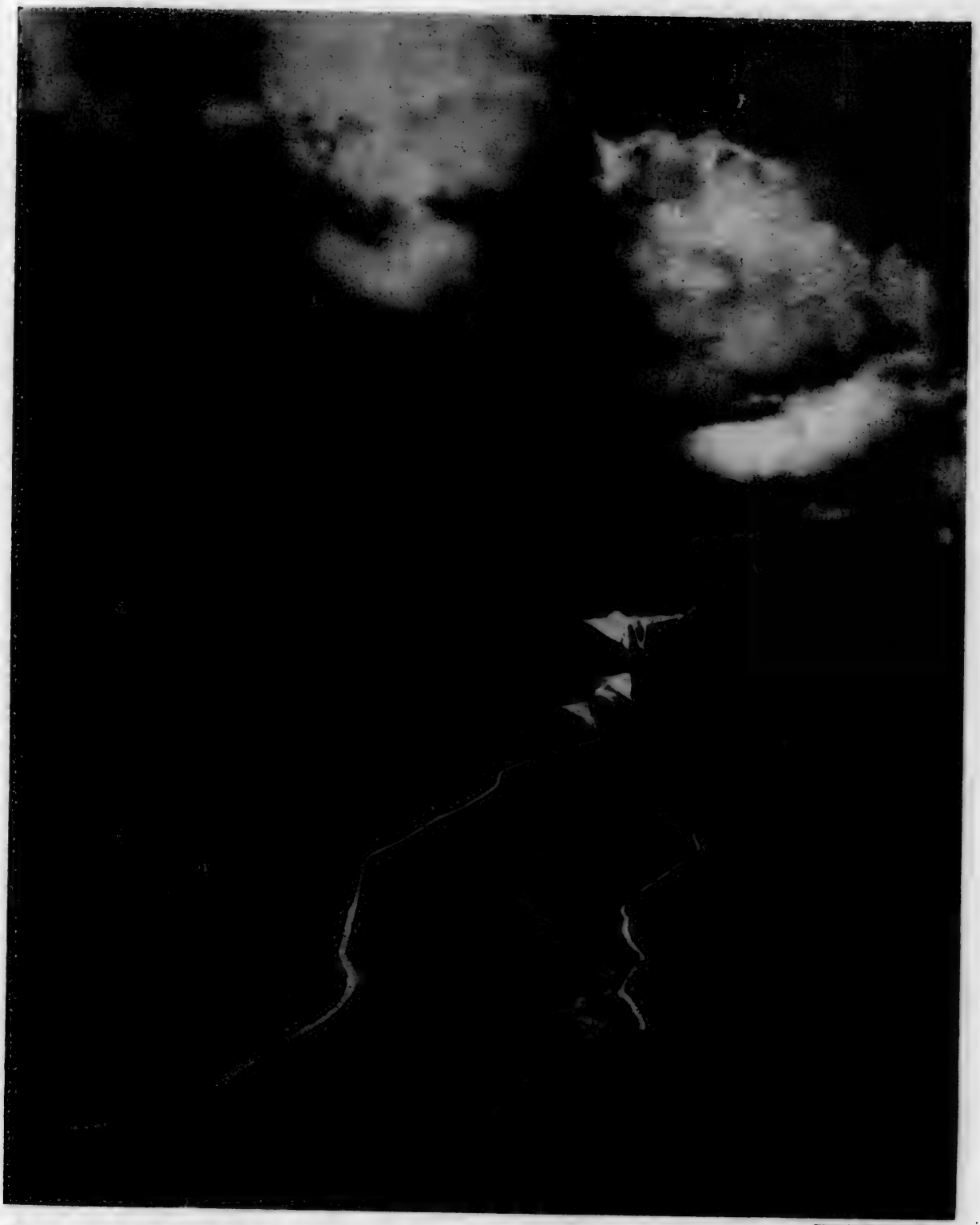

Photo by Marjorie Vogt

Highway erosion from a new road in the Motatan Valley, Venezuela. Millions of tons of topsoil are being dumped into the Motatan River, and the highway itself is endangered by the shifting agriculture above. This situation also exists in the United States and contributes greatly to the silt carried by streams.

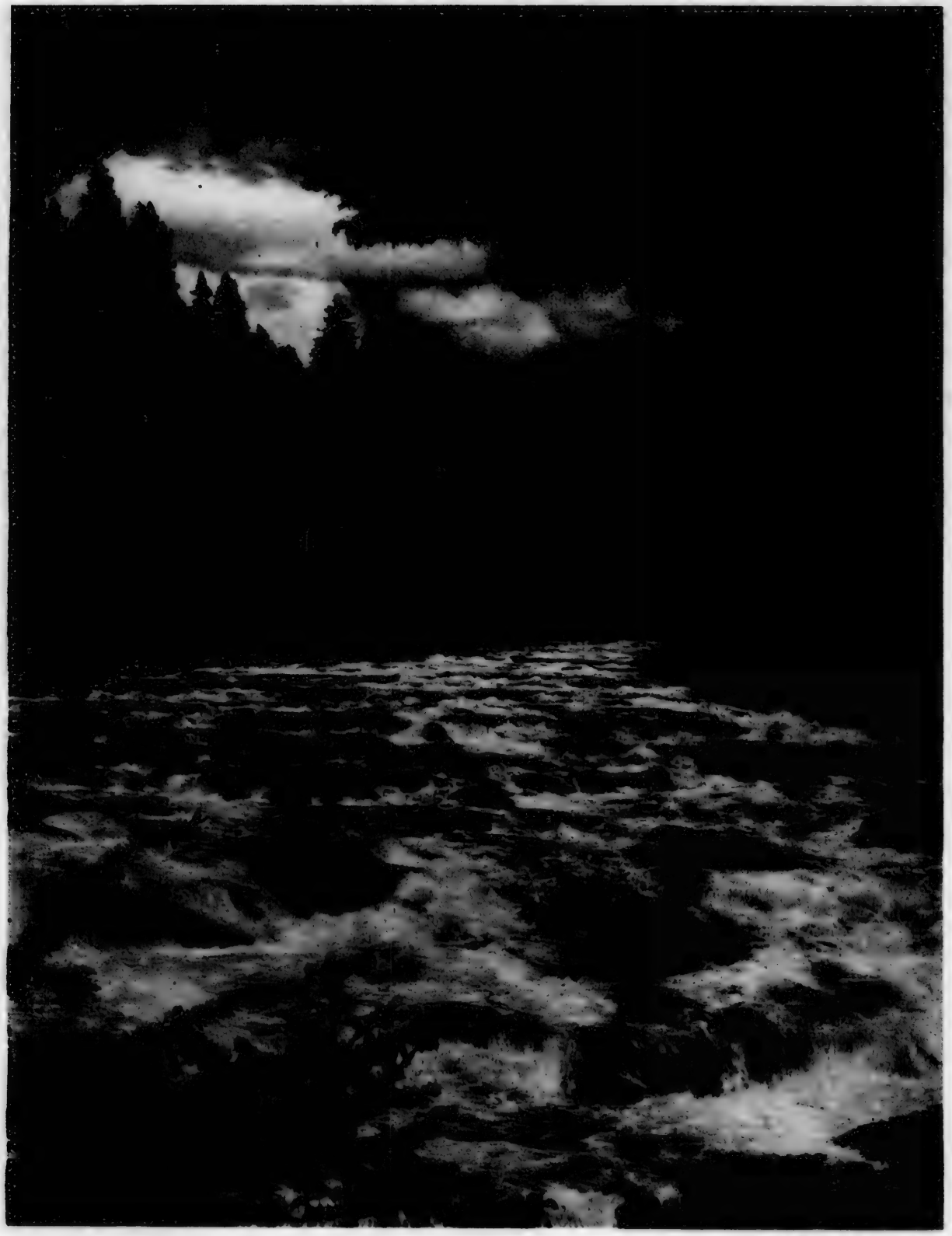

Photo by Bureau of Reclamation

A typical mountain stream flowing between well-wooded banks and bound for storage in a Reclamation reservoir. This particular stream is in the north fork of the Payette River.

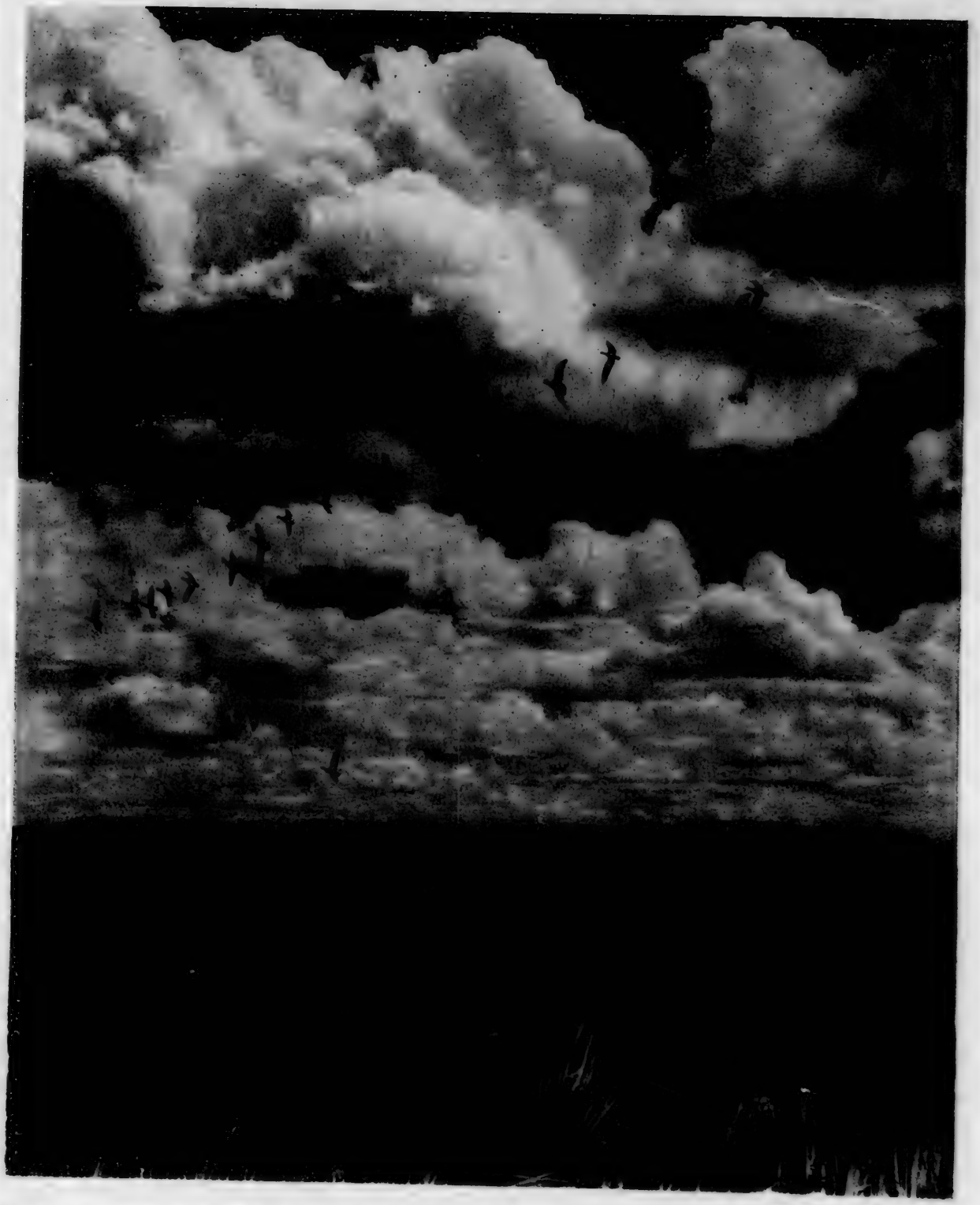

Photo by Bureau of Reclamation

An unusual picture of a flight of ducks over Tule Lake in Northern California, which adjoins the Klamath Reclamation Project. Water birds will be safe in America only when we provide breeding, wintering and resting places for them. It is an important phase of the Conservation Movement.

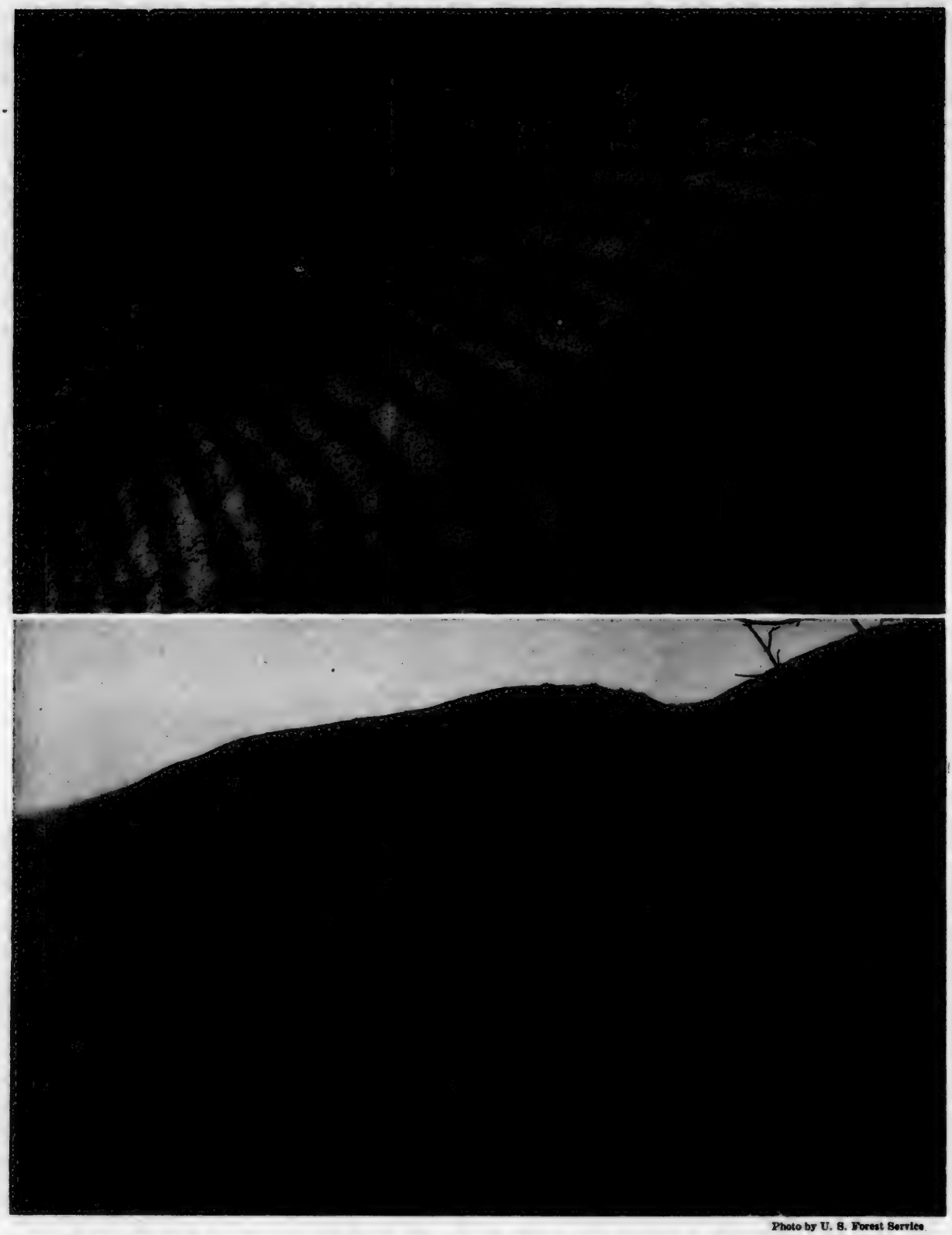

Photo by U. S. Forest Service

Top. The stabilization of raw mountain road slopes and fills is an essential to a reduction in the sediment loads of streams as well as to the cost of maintenance. A great variety of treatments, all featuring vegetation, is being used. *Bottom.* On Western Mountain slopes where the brush chaparral cover has been destroyed by fire, mustard seed is sown to provide protection to the soil. The mustard completely disappears in about five years as the slower growing native vegetation reclaims the area.

Ideals of a Professional Soil Conservationist

HENRY W. SCHMITZ

NATION-WIDE RECOGNITION of soil erosion exploded with atomic suddenness on public attention in the early 30's. During the following decades it advanced rapidly to the forefront as a major American problem. Our nation has become aware of a tremendous vacuum in our soil and water resources, which had developed because millions of acres of topsoil had slipped into gullies and oblivion during the past generations. A federally supported operational program, first in the form of demonstrations, and finally in direct technical on-the-farm assistance in an action program through Soil Conservation Distrcits, organized under state law, created in a large measure the demand for the professional soil conservationist of today. He is the result of an urgent need for highly trained and experienced men to serve an ailing agriculture, suffering from serious soil losses due to erosion.

It is not my intention to define professionalism in soil and water conservation so that it may serve as a guide for membership in our Soil Conservation Society of America. But it is my desire to designate ideals for those people who probably qualify as professionals in this immense field. When applying a commonly accepted definition of professionalism, we find *"it is a person receiving pay for doing something well and expertly."* An architect, engaged in one of the oldest and most honored of professions, has acquired his present status through training and experience. The professional soil conservationist has acquired his status as a professional through training and experience which qualifies him for a wide range of activities in soil and water conservation. Like the architect, he calls upon his training and experience in developing plans for controlling erosion and conserving soil and water. He may assist a farmer or groups of farmers in planning and applying conservation practices and land treatment or he may supervise other people, usually of lower professional competence, who supply the practical service by assisting farmers in establishing practices and land treatment. These people, sometimes referred to as subprofessionals, are extensively engaged in furnishing technical assistance to farmers in Soil Conervation Districts that are receiving federal cooperation. Their competence was acquired largely through experience. They do not have a scientific background, usually acquired through formal training that qualifies them to select, adapt, or adjust techniques to fit new and different situations with which they are confronted. The ability to develop effective plans and supervise the application of such plans for erosion control and soil and water conservation on the farms of a community is the mark of professionalism.

Henry W. Schmitz holds the position of a District Conservationist with the Soil Conservation Service at Ottawa, Kansas. Mr. Schmitz presented this paper on a panel—How Should We Train the Soil Conservationist?—along with three other papers at the Annual Meeting of the SCSA held in St. Louis, November 10-12, 1949.

Ideals Involve Land and People

Whether he deals with individuals or groups, the professional soil conservationist is confronted with two major factors in the planning and application of soil and water conservation. These factors are the land and the farmer. He makes a physical inventory of the land and an analysis of the farmer. He uses both as a basis for developing a conservation plan. Both the land and the farmer are key factors in getting the conservation job done. The professional soil conservationist makes technical applications when dealing with the land. Since he also must deal with the farmers, and groups of farmers and their families, he makes use of techniques in human relation. All of his ideals will involve these two factors.

Ideals imply a standard of perfection that usually serve as patterns to follow which, in a large measure, influence the end product. There may be some inherent ideals in a true professional soil conservationist. Other ideals are acquired, developed, and improved through training and experience. The need for erosion control and soil and water conservation is great and the ideals of the professional soil conservationist must serve in helping fulfill this need.

There is only one ideal which the professional soil conservationist must have and which must become a part of him. It is: To have every farmer use every acre of his land according to its capabilities and treat it according to its needs. Or should it be stated, to get all the necessary soil and water conservation practices on the land permanently in the least possible time at the lowest possible cost? As we examine it more closely, this ideal unfolds before us and we see that it really consists of a number of separate convictions. These convictions have become so firmly fixed that they are vital parts of the ideal. I will discuss each of these convictions as though they were in themselves ideals in the terms in which they contribute to the principal end.

First, *a professional soil conservationist should have an inborn love for the land.* I think of the minister's son who was two generations removed from the land,

but who returned to the farm, made good, and became a real leader in the field of agriculture. His father and grandfather had achieved renown in the field of religion.

This minister's son had a deeply ingrained love for the land and definite ideals for its care. Some men have a love for acquiring land and seem to get satisfaction from possession alone. A real love of the land must include a thorough appreciation of the wise use and treatment of that land. A professional musician, the owner of a costly violin, usually knows and understands how to handle so valuable an instrument so that it will produce the beautiful tones for which it was created. The trainer of race horses, in addition to being a lover of horses, must appreciate and understand the handling of his charges so that he may manage them to win as many races as possible. The real love of the land includes the spirit of conservation.

Leadership and Devotion to Work Are Essential Ideals

Second, *the professional soil conservationist should have an ideal for full leadership,* as this is his opportunity to serve and lead people individually and in groups toward getting soil conservation on the land. Here he will see himself in an enviable positon in his community, with a great demand for his services. Even to begin to meet this demand in the future, groups of farmers must be served whenever this is practical and feasible. The professional soil conservationist must firmly believe that his greatest opportunities for leadership in the fight against soil erosion lie in offering his services through groups of farmers. Farmers and land owners are ready to do something about soil and water conservation only when they are convinced that it will contribute to their welfare.

The ideal of leadership should be the spark that impels the professional conservationist to keep before the people, constantly, honest, factual data and information by means of both the written and spoken word through the medium of showing results, and the examples of those who have succeeded. In no place are American farmers forced to practice soil conservation. So long as our demorcacy prevails, we will have the opportunity to lead well-informed rural people along to a complete conservation system of farming. The leadership ideal of the professional soil conservationist should inspire him to meet the great need for farmers to be well informed on the principles of soil and water conservation and for the public generally to be fully aware of the dangers of soil erosion and the need for its control. This ideal of leadership should inspire the professional soil conservationist to help in a program of education in soil and water conservation in our schools from kindergarten through high school. It should inspire him to do what he can to help provide conservation education in the college curriculum so that potential teachers, farmers, professional workers and others may have an appreciation of the vital need for soil and water conservation. It should inspire him to help make available curricula in colleges and universities leading to a major in soil conservation for those who wish to become specialists or workers in the professional field of soil conservation. Beyond this he should help newspapers, magazines, radio, movies and television carry the gospel of soil and water conservation to the far reaches of the nation.

A **third** ideal necessary for the professional soil conservationist *is genuine love and devotion to his work.* This includes a balanced interest in and attention to all phases of his work, real enthusiasm for what he is doing and deep devotion and a sense of loyalty to his profession. The professional soil conservationist must love all phases of his profession and apply the practices and techniques for sound practical reasons rather than for personal likes or dislikes. The tractor has become an indispensable part of the average midwestern farm and the soil and water conservation program has been influenced tremendously by its use and misuse. The professional soil conservationist who sees only the tractor and the mechanics of farming operations, because he likes tractors and machinery, has a very imperfect ideal and unbalanced interest. When he thoroughly enjoys working with farmers and groups of farmers in the interest of soil and water conservation, he is usually so enthusiastic about his profession that it infects fellow soil conservationists as well as the farmers whom he serves. Real enthusiasm for his profession develops into deep devotion and a sense of loyalty to the extent that no other interests can reduce his effctiveness and usefulness to the cause of soil and water consrvation.

Fourth, the professional soil conservationist must have *an ideal of the fully completed product.* He must be able to visualize the effective soil and water conservation principles in operation on the land. This would amount to a mental picture of the farm fully protected against soil erosion, with all land treatment completed and proper land use in effect. Like the construction engineer who visualizes the graceful bridge that will sime day span the mighty river, so must the professional soil conservationist be able to see in his mind's eye the practices, structures and treatment and proper land use on a well-protected farm. This ideal will begin to take form in the mind of the professional soil conservationist as soon as he begins preparation of plans for erosion control and soil and water conservation for a farm or farming unit. It will grow and develop fully as additional data and information are gathered and the plan completed. This ideal of the completed plan aids him in developing with the farmer ideas as to new procedure and

Figure 1. A touch of beauty and a sign of perfection of a completed soil and water conservation job is the rule where high quality work prevails.

techniques, the departure from present practices, and the expected beneficial results. It also aids in developing a preliminary estimate of costs in terms of material, labor and time necessary for complete application of the plan for erosion control and soil and water conservation.

Beauty and Quality Enhance Land Treatment

Fifth, there is *the ideal of beauty and quality that should embody the plans and the land treatment for soil and water conservation* with which the professional soil conservationist is concerned. A touch of beauty, a sign of perfection and the solidness of a completed soil and water conservation job, may be noted where work of high quality is the rule and the efforts have been painstaking. Where soil and water conservation has been effectively applied to the farm lands of a community it lends a touch of softness, symmetry and smoothness. Effective land treatment and proper land use follow nature's own patterns and principles and thereby create a pleasing appearance. A well contoured fields seem to be a natural part of a modern rural scene. The harshness of straight rows and square or rectangular fields, give away to the roundness, softness and beauty of the ideal soil conservation plan in operation. Effectiveness in controlling and preventing soil erosion, and applying soil and water conservation, depends to a large degree on the quality of the work of planning. The professional soil conservationist will be satisfied only with highest quality performance. This must be a part of his ideal of beauty and perfection.

Sixth, the professional soil conservationist must have *an ideal which embodies the urgency of getting erosion control and soil and water conservation on all the land in the least possible time at the lowest possible cost.* This comes from a conviction that time is a major factor which will eventually determine losses or gains in natural resources and human welfare. Delay in the soil conservation program is costly in the long run. I could cite many cases of individual farms where applying a program for soil and water conservation was put off, so that when it was done the cost—in money, time of professional men, and labor—was nearly doubled. The nature of soil and water resources makes their replacement slow and difficult. It has been found that nature requires from 700 to 1,000 years to develop one inch of topsoil.

The recent reports of spiraling population add further notes of urgency for getting the soil and water conservation job done, in order to meet these new demands on the soil and water resources. The urgency for doing soil and water conservation is further emphasized when one takes into consideration the present rapid rates of deterioration of some soils and water resources. The professional soil conservationist should recognize the variable periods of time required to get results from practices applied and complete treatment for the best use of the land. Like other problems dealing with things organic, soil and water conservation is never static. It requires constant attention, for man's use of the land tends to unbalance nature's plan for conservation. Con-

stant vigilance as well as immediate attention is necessary to balance the scale between our needs and the soil and water resources we have left to supply these needs.

The **seventh** ideal of the professional soil conservationist should be *self-analysis and self-improvement in his profession.* This is the natural result of all the ideals I have discussed before. If he has a love for the land, values real leadership, loves his profession, visualizes his goals and what he is striving for, is satisfied only with work of high quality and perfection, and recognizes the great urgency of getting soil and water conservation established, he will practice self-analysis and self-improvement as a matter of course. His self-analysis and improvement will identify him as one who makes his profession his career. The successful surgeon, who came out of his internship equipped with the latest knowledge and skills in the field of surgery, finds after a few years that there are improved techniques in his profession. To enable him to keep abreast of his profession and serve mankind better, he needs refresher courses. Self-analysis causes him to see his needs and the refresher courses enable him to realize his ideal.

How long would the mechanic last who declared that he had learned how to do all automobile repair jobs when the Model "A" Ford was a standard car? Each year automobile manufacturers bring out many new models. This sends hordes of mechanics off to school to learn the latest in auto mechanics. I am not necessarily advocating that all professional soil conservationists take long periods of leave from their work for formal college courses, although this may be desirable in some cases. No opportunity, however, should be lost to secure new information and acquire new and improved techniques as aids in giving better service in soil and water conservation. There is no one in a better position to determine what he needs and how he can improve himself than the professional soil conservationist on the job. Day by day he can compare himself and his abilities with the demands of his profession. He must determine for himself how self-improvement is to be done.

Efficient Management Is Basic to Ideals

The **eighth** ideal is *efficient management of his resources in the fight against soil erosion and for the establishment of adequate soil and water conservation programs.* This ideal is important to the professional soil conservationist whether he manages merely his own time or supervises others, whether he is in private practice or is employed by public agencies, corporations, or individuals. Items concerned in reaching this ideal are available manpower, equipment and materials. They represent money which comes from private or public sources, or both. The degree of efficiency in management is usually measured in terms of results obtained. Industry can measure efficiency of its mines or plants from day to day because there is a daily output that can be compared to man-hours, costs, or whatever else they desire. For the professional soil conservationist the payoff is not as immediate. Benefits from some phases of soil con-

Figure 2. So long as democracy prevails we will have the opportunity to lead well informed rural people to a complete conservation system of farming.

servation begin to occur almost immediately, but others require years to become evident. Most farmers now desire assistance in solving their soil and water conservation problems. They cannot all be first. The present available man-hours of professional conservationists' time and materials make it impossible to serve all immediately. This requires management. Efficiency in that management will help in getting more effective soil and water conservation on more acres at the least possible cost, which is the principal goal of the professional soil conservationist.

Efficiency in management requires effective application of all the other ideals that I have discussed. Each of these will aid the professional soil conservationist in realizing fully the effective and complete application of soil and water conservation to the farm lands of America. Certainly love for the land with which he is working should be a constant inspiration to him and an aid towards efficient management. Leadership and effectiveness in meeting and dealing with people is an essential factor. Here lies the opportunity for stepping up production and accomplishment by planning and working with groups, by effective information for the public, soil and water conservation education in schools and colleges. When one loves his job he usually works a little harder at it and at the same time gets enjoyment out of it. Certainly this should contribute to management and efficiency. A mental picture of the goal or the product for which he is striving is essential. Without it, how can one marshal and direct his forces efficiently? The quality, perfection and beauty of effective soil and water conservation programs on farm land will serve as stimulants for greater achievements. The urgency for getting soil and water conservation on land will require short cuts to greater service by the professional soil conservationist without sacrifice of quality. He must manage efficiently if he is to meet the great demand for his services. Self-improvement, the result of self-analysis, is so important to efficient management by the professional soil conservationist that those who hesitate in this will eventually fail in the profession.

There also seems to be a need for the effective use of large doses of just plain horse sense to develop balance in management so that all phases of the soil and water conservation program will go ahead in proper proportions. Whenever there is efficient management, the ideals of the professional soil conservationist include a firm stand on high morals and solid integrity. He is diligent and usually expects to do more than just the minimum expected of him.

After all has been said and done concerning efficient management there still is a final something that is necessary to get it done. Much has been said about the working principles of the atom bomb. Out of all of it I recall a statement by an eminent authority that scientists were first able to manufacture the several ingredients of the bomb, but for a while they were unable to cause them to explode. So, the method of exploding a bomb was the key to releasing one of the greatest forces on earth. We might look at efficient managemnt as the key to getting soil and water conservation on the land. It is that little trick which some have and all professional soil conservationists need. It might be said that it is the bringing together of all the forces, materials and ideas in such a manner and at such a time that the job will be done.

These ideals seem to me to be real, human and practical. Behind each there appears to be an emotional and practical driving force which should serve well the professional soil conservationist who accepts them. Like harmony in a song, these eight ideals play the melody of success for the professional soil conservationist. They open up for him great opportunities for effective professional work in the field of soil and water conservation and service to his fellow men, and provide insurance for the unborn generations of the future.

Industry Relies on Natural Resources

In American industry today about one-half—whether stated in terms of jobs or plants or output—relies directly on the renewable natural resources for its principal raw materials; over one-third of the nation's power is hydroelectric; about one-fifth of industrial kilowatt hours are devoted to processing organics; nearly one-fifth of the revenue freight of the nation's railroads derives from the carriage of raw materials alone which are the products of our renewable natural resources.

So complex and interdependent is our economic structure that any material failure along the line must necessarily be felt by all.

Failure is possible. For instance, we cut and lose to fire and pest considerably more lumber than we grow. Stated in terms of prices, in about sixteen years the general commodities index has risen about one hundred per cent. In the same period the price of lumber has risen nearly two hundred and fifty per cent. That is a reflection of a world lumber scarcity staring us in the face.

The crop picture is more complex and cannot be stated in simple terms. Our attention is captured, and our judgment confused by the work of the scientist and engineer who have produced the marvels of hybrid corn, the "wonder" fertilizers, the new machines which have brought in new methods including a tremendous step-up in quantity production.

—FAIRFIELD OSBORN

Recent Research Reviews

JAMES H. STALLINGS

The Reviews by J. H. Stallings that follow are a regular feature in the JOURNAL. It is hoped that the projects reviewed from time to time will be helpful to conservationists everywhere. Members of the Society are urged to indicate their interest in the kind of research work that should be reviewed.

Microbiology of the Soil: A New Direct Microscopic Technique. *By* YAO-TSENG TCHAN; *Ann Inst. Pasteru 73, pp. 695-696, July 1947. (Translated from the French by Roy C. Dawson).*

The author proposes a new microscopic technique for making biological analysis of soil. It consists of moulding the soil in a Petri dish, with or without the addition of chemical substances, depending on the objective in view; after a period in the incubator at 28°, a slide is impressed against its surface; the microscopic examination is made after fixing in the flame and staining with phenolic erythrosine. Colonies of generally homogeneous bacterio, filaments of actinomycetes and of fungi with their fructifications can be distinguished in the microscopic field. The impressions can be made upon slides repeatedly during the course of the culture, the whole giving a true moving picture of the evolution of the flora.

Stubble Mulch Management for Water Conservation and Erosion Control on Hardlands of the Southern Great Plains. *By* CHARLES J. WHITFIELD, C. E. VAN BUREN *and* WENDELL JOHNSON; *Texas Agr. Exp. Sta. Bul. No. 711, June 1949.*

This bulletin contains a resume of the stubble mulch tillage studies carried on the past 7 years at the Amarillo Conservation Experiment Station. It concerns studies made of stubble mulch practices in growing winter wheat on Pullman silty clay loam, a deep, fine textured slowly permeable hardland soil, high in fertility and moderately high in organic matter under native conditions. Four types of implements, two plows and two subtillage machines, were used on plots planted to wheat year after year. These were the oneway plow, the moldboard plow, the Noble cultivator, and a subtillage machine developed at the station. Two types of implements, the oneway plow and the Amarillo subtillage machine, were used on plots planted to wheat one year and fallowed the next year.

Anaverage of 2.6 bushels, or 21 per cent, more wheat per acre was obtained from the continuous wheat plots which were subtilled than was produced after using the moldboard plow, and 1.9 bushels, or 14 per cent, more than where the oneway was used. An increase of 2.8 bushels, or 15 per cent, was recorded in favor of the subsurface sweep machine over the oneway in a wheat and fallow system. These differences in yield are highly significant. The effects of the stubble mulch tillage have been accumulative through the 7-year period. The improvement was due in part at least to an improved physical condition and a better moisture-fertility balance in the soil.

In addition, fallowing has made possible, the production and maintenance of a stubble mulch to protect the soil from blowing regardless of the occurrence of periods of subnormal precipitation.

Experimental Use of Fertilizer in the Production of Fish-Food Organisms and Fish. *By* ROBERT C. BALL; *Mich. Agr. Exp. Sta. Tech. Bul. No. 210, March 1949.*

Twenty-one ponds at three Michigan fish hatcheries were utilized in the summer of 1946 for experimental work to determine the value of fertilizers in the production of fish. Certain operational difficulties made evaluation of the effects of the fertilizer on the bass-bluegill combinations, and on the minnows difficult, but the general indication was that there was a greater production of these fish in fertilized waters. There was a more clear-cut indication of greater production of crayfish, tadpoles, and other fish in the fertilized waters and it was in the production of fish-food organisms, the lower invertebrates, aquatic insects, and plankton that the greatest difference was noted. The production of invertebrate organisms, as determined by dredge sampling, was 42 per cent greater in the fertilized ponds than the non-fertilized ponds, and the production of plankton organisms was 3.3 times as great.

Land Use Experience in Southern Great Plains. *By* H. H. FINNELL; *USDA Cir. No. 820, October 1949.*

The limitations of land must be recognized clearly before good judgment in land use choices can be used. Experience has proved that shallow, moderately sandy and deep, loose sand-hill soils of gentle slope or steeper cannot be kept productive under cultivation anywhere in the 14- to 20-inch rainfall belt. Shallow-depth hard lands, both flat and sloping, have failed in all areas of less than 18 inches average rainfall. Nearly level medium-depth moderately sandy lands, on the other hand, stood up well with suitable practices under rainfall as low as 16 inches. Deep, nearly level hard lands, the best of the High Plains wheat soils, can be farmed with appropriate precautions wherever found. The productivity of high-capability lands, can be as seriously affected by topsoil removal as that of low-capability lands.

These conclusions are based on a study made of conditions in 20 counties centering on the juncture of Colorado, Kansas and Oklahoma. A physical survey of the land in the area was first made in 1936 and again in 1947. The 1936 survey provided a record of the land use in effect at that time and provided descriptions of soils, slopes, vegetation and a record of the nature and extent of soil erosion that had taken place before that date. The 1947 survey served as a basis for determining land use experience under average farm conditions. The purpose was to determine what kinds of lands had been abandoned since 1936 and what has since happened to them, in order to establish a sound basis for present and future action.

Bill Ebbs' Siphon Primer. *By* GARFORD L. WILKINSON; *The Reclamation Era, Vol. 35, No. 10, pp. 229-230, October, 1949.*

The Siphon primer, an incomplicated, inexpensive gadget attached to the end of a siphon tube bids fair to solve a lot of problems for the Irrigation farmer. With this new device attached to the end of a siphon tube, all that is necessary is to dunk one end of the tube into the water, flip the curved tube across a ditch bank and the water flows as if it were coming from the old mill stream. Water remains in the siphon several hours after the water has stopped flowing in the ditch. The siphon doesn't lose its prime; doesn't require resetting. When the flow of water is resumed in the ditch the siphon valve automatically starts functioning again. It has water-saving properties, as it makes possible perfect control of the streams entering each furrow, and prevents waste which too often results from overlarge apertures or flows from the ditch.

This siphon valve is extremely simple. It is made of rubber with various sizes being designed to fit any standard metal or plastic siphon. From the end where it slips on the siphon, the valve flares into a "L." A valve designed to operate on a 2-inch siphon measures about 4½ inches at the mouth or outlet. Other valves vary in proportion to the size of siphons on which they are fitted.

The valve, constructed entirely of heavy rubber, remains open while water is flowing through. As the flow decreases, the valve opening also is reduced. When the flow of water ceases completely, the valve automatically closes tight.

Range Reseeding by Airplane Compared with Standard Ground Methods. *By* GEORGE STEWART; *Agron. Jour., Vol. 41, No. 7, pp. 283-288, July 1949.*

The author describes the ground methods which have so far been found successful on range lands and the relative success of comparable airplane seeding from the experimental data and experience which are available.

On most range lands, reseeding by standard on-the-ground procedures developed from careful research has so far given much more dependable results than has airplane seeding, both in getting a stand and in obtaining good yields of forage. The yields from airplane seeding on sagebrush ranges have been found to be from 50 to 150 pounds of air-dry forage per acre. On similar areas, the yields obtained by recommended ground procedures have been from 300 to 3,000 pounds of air-dry herbage, or 5 to 50 times as much as from airplane seeding.

To insure successful growth of reseeded species in the arid western United States, all seeds need to be covered to a shallow, uniform depth. Where the seedbed is such that covering can be provided by natural means as in loose soil, deep ashes, or fallen leaves, the airplane is a promising means of seeding that deserves further investigation. Rapidity of seed distribution and coverage of rough or obstructed terrain are the greatest assets of the airplane.

Sand Lovegrass—Producer of Beef. *By* ALBERT L. BROWN *and* E. H. MCILVAIN; *What's New in Crops and Soils, Vol. 1, No. 9, pp. 14-15, August-September, 1949.*

Native sand lovegrass is one of the more palatable and nutritious grasses being used in reseeding unproductive and abandoned farm land in the Southern Great Plains. This lush-growing, fine-stemed, medium-tall bunchgrass, with its dense growth of soft basal leaves, produces a high yield of excellent forage. A prolific seeder, it produces a large quantity of easily harvested seed, which makes it a valuable plant for commercial seed production. This also enables it to fill out thin stands voluntarily.

A reseeded pasture of sand lovegrass has consistantly proved superior to every other grass or grass mixture and to native range. The sand lovegrass pasture has produced an average of 422 pounds of live-weight gain per Herford steer and 108 pounds per acre. This is an advantage of 30 pounds per head and 73 pounds per acre over native range. The sand lovegrass also carried 108 more head per section.

Studies in Gully Control. *By* GEORGE W. HOOD; *Ark. Agri. Exp. Sta. Bul. 486, May 1948.*

Gully control was established on a 32-acre area. This land had been abandoned for agricultural purposes. In 1938, when the work began, there were 29 active gullies which made up 5 separate gully systems. Different practices were used on different gullies in order to compare their effectivenss. All of the practices used were ones which a farmer could easily put into effect on his own land without cash expense.

(Continued on page 46)

BOOK REVIEWS

A SAND COUNTY ALMANAC. *By* ALDO LEOPOLD. *Oxford University Press, New York. 1949. $3.50.*

This is an extraordinarily difficult book to review. Many criticisms have appeared in the lay press. All that I have seen have been enthusiastic, with a puzzled overtone of questioning: "Why haven't I run across Leopold's writing before?" That the book will be well received in the professional journals there is no doubt. Aldo Leopold was without a peer in his field. The question remains: Just how good is *Sand County Almanac?* Can it be as good as it seems? Several readings, thinking about it from time to time during several weeks, and a critical comparison with the classics of nature writing, lead me to the inescapable conclusion that here we have one of the best. No one can, of course, know what future reading tastes will be nor, indeed, in this scientific era, how long there will be any future reading. But if the taste of the past is any guide, it is safe to assume that *Sand County Almanac* will be read for decades, and probably centuries, to come.

Aldo Leopold had, of course, one great advantage over such predecessors as Gilbert White and Thoreau; he had years of ecological research to build upon. And the fact that he was an ecologist, with the sense of relationships this science develops, gave him a key to the meaning of his observations and conclusions that earlier writers lacked. He not only never overlooked the forest for the trees, but clearly saw the understory and the dynamics by which the forest lived. None of the first rate nature writers I can think of even approached him in scientific understanding, except Beebe, and he writes more as a naturalist than as an ecologist. This is in no sense a derogation of the older men; Newton could scarcely have developed quantum mechanics, and Einstein necessarily built on the work of his predecessors. Perhaps we may find compensation for the scarcity of good nature writing, today, in the superb quality of such a book as this.

That the book will be widely read by those interested in natural history, wild life, ecology, and first rate nature writing, is a foregone conclusion. It is to be hoped, however, that it will also become well known among intelligent people who, in one way or another, influence the destiny of the peoples of the world. Leopold the philosopher has quite as important a message as Leopold the ecologist; perhaps it is more important since it is told in such beautiful and persuasive prose that it might even penetrate the carapace of words and fixed ideas that seem to be almost a genetic hand-me-down from three generations of Economic Man. I sincerely hope that it will be read by everyone interested in conserving our soil and water; the processes that are basic to what we are trying to accomplish, their inter-relationships, and the significance of those inter-relationships, will be made clearer to most of us by Leopold's wisdom. Some of the essays, many times reprinted, have already become classics; we are fortunate to have them now, between covers.

The book is sure to be read with mixed joy and sorrow by everyone who was fortunate enough to have his life touched by Aldo Leopold. There will be joy in finding in this volume so much of one of the greatest human beings it has been the fortune of most of us to know; through the sensitive, often poetic prose come the simplicity of the man, and the kindliness, humor, wisdom, humility and, perhaps most of all, his own joy in the Great Possessions that nature offers to those who approach it with understanding. And sadness there must also be that Leopold's life was cut off at the beginning of what might well have been its most productive decade.

Charles S. Schwartz's exquisite illustrations are almost worthy of the text, and that is high praise, indeed.

—WILLIAM VOGT, *Washington, D. C.*

CRISSCROSS TRAILS. *Narrative Of A Soil Surveyor. By Macy H. Lapham. Willis E. Berg, 1512 Spruce Street, Berkeley, California. 1949. Pp. 246, figs. 32. $3.00.*

Between the covers of *Crisscross Trails* by Macy H. Lapham, I discover the most informative and enjoyable narration of western travel that so far has come to my attention. And Willis E. Berg, the publisher, merits high commendation for his unusually attractive job of off-set printing.

During the past fifty years the author, as an employee of the U. S. Department of Agriculture, has travelled his crisscross trails along the western back roads and highways. Important and unimportant people, places and incidents (sometimes whimsical and sometimes serious) crowd along in sparkling profusion, but they only serve to emphasize the central idea of the book—that of tracing, step by step, the origin and steady growth of a national program of soil surveys.

To illustrate: Chapter one recounts in detail the initiation of a Division of Agricultural Soils in the Weather Bureau in 1894; how this became the Division of Soils in 1897; and the Bureau of Soils in 1901. Yet, relative to his appointment in September, 1899, Macy Lapham writes: "*Notice of my appointment was given by an elaborately printed and embellished certificate signed in person by the Honorable James Wilson, Secretary of Agriculture. This stipulated that the appointee would be paid the sum of $480 per annum—in striking contrast to the present-day skimpy piece of thin paper,*

signed with a rubber stamp, certifying appointment to a higher salaried job."

Of his first days in Washington, D. C., he recalls scores of individuals with major and minor anecdote. Witness: "I took my meals at a private home having a fraternity atmosphere; this house is referred to by David Fairchild in his *The World Was My Garden.* The group included Guy Collins, Walter T. Swingle, Carl Schofield, and several others. . . . At rare intervals after protracted planning and preparation . . . we indulged in a rijsttafel, the national dish of Java that had been introduced by David Fairchild on his return from . . . the Orient. This consisted of a gastronomic complex of boiled rice, chicken croquettes, fried chicken livers, fried bananas, sweet cucumber pickles, canned corn, salted almonds, shredded coconuts, canned sardines, and other ingredients that might be varied from time to time; this was topped off with a liberal helping of curry sauce."

Chapter two deals with the horse and buggy days in southern and northern Utah, and in coastal and central California. While Macy Lapham was still in the latter locality, Secretary Wilson advised him that a Miss Julia R. Pearce had been appointed and was reporting to him for regular field duty. Thus: *"I was to become the first, and in so far as I know, the only chief of a field party to be officially entrusted with an unaccompanied lady assistant."*

Successive chapters trace subsequent surveys in several western states—the developing use of plane table, alkali bridge, odometers, bicycles, boats, and the first of the early automobiles. People, places, incidents, continue to provide a bright relief from the occasionally lengthy details of scientific advance in the face of a not always understanding and supporting public attitude. Macy Lapham reports on a two-day trip which he made in 1911 on foot with C. F. Marbut and Harvey L. Westover through the dense fir forest of Western Washington. "Taking an evening train out of Chehalis, we got off at the sawmill town of Pluvius, where we slept in an abandoned lumber camp. The next morning, with a couple of loaves of bread, some canned sardines, one light blanket, and an overcoat that was carried by Dr. Marbut, we set out. . . . For most of the day we kept to the higher ridges covered with an almost pure stand of Douglas fir. Into this densely shaded forest scarcely a ray of sunshine reached . . . to the forest floor. . . . At that time we only vaguely recognized the morphology and processes of development of these podsolic forest soils. . . . Well along in the second day we came out on logging and wagon roads which took us into Skamokawa on the Columbia River."

Rapidly moving on to the twelfth chapter (there are fifteen), we who are interested learn many details of Hugh H. Bennett's early interest in soil erosion and its prevention. Macy Lapham says *"Late in July, 1930, I drove Old Job to Pullman, Washington, where I was to meet Bennett, Dr. A. G. McCall, S. H. McCrory and W. A. Rockie of the Bureau of Chemistry and Soils, and several of the State College and Experiment Station staff. Our mission was to locate somewhere in the region of Palouse soils a site for one of the ten erosion experiment stations that had been authorized."* It was shortly after this occasion that "Horace," an unbelievably large and belligerent rainbow trout, was hooked and lost by Macy Lapham in a deep pool in the Oro Fino River.

Those who know Macy (and all his friends know and address him in this informal manner) will want to read every line and page of *Crisscross Trails,* personally recalling many an enjoyable evening of cribbage and light conversation after a vigorous day in the field. Those who know him only slightly, or not at all, should not miss this opportunity to know him well. In a very real sense, *Crisscross Trails* is Macy—a very knowing and considerate friend.

—STANLEY W. COSBY, *Portland, Oregon.*

TREES—The Year Book of Agriculture. *1949. U. S. Government Printing Office, Washington, D. C. Price $2.00.*

"Trees" is a book that no conservationist can afford to miss placing in his library. It is one of the most complete encyclopedias on the subject of growing, protecting, managing, and enjoying trees and tree covered land that it has ever been my good fortune to uncover. Aside from its completeness, it is a beautiful book both outside and inside with forty Kodachrome pictures and many excellent pen and ink sketches. Its two column style of printing is most economical of space and allows the 916 pages to contain well over one-half million words, plus a very complete index of 27 pages. Of great value also is the bibliography of source material which may be used by anyone desiring to delve further into any phase of the work covered in this book.

Because of the wide experience of the men, both within and without the Department of Agriculture, who have authored the book, there is little monotony in style or method of presentation. This is of great advantage to a person who intends to read the whole book. However, it may be annoying to one who is browsing, or using the book for reference, if he finds the author of a subject, in which he is particularly interested, doesn't present it in a style to his liking or repeats some of the information used by another writer on a similar subject. Be that as it may, neither weak presentation nor repetition occurs often enough to be a serious criticism.

Of interest to conservationists who are working in country where a woodlot is part of the farm, would be

such topics as: *"Harvesting The Small Forest"; "Growing Better Timber";* and *"The Farmer and Christmas Trees"*—just to mention a few.

Some of the articles; such as: *"Watersheds and How to Care for Them"; "Timber Cutting and Water Yields"* and *"How to Help Control Floods"* cover another class of interests.

To those whose hobby is identifying trees, there is a gold mine of information in the back of the book in the form of keys for identifying both wood and trees.

To the amateur botanist, the leading article—*"A Tree Is A Living Thing"* is of great value in explaining the growth habits of plants in general and of trees in particular.

The hunter, the fisherman, the horse back rider, the camper—in fact almost any person who seeks recreation out of doors will find a wealth of valuable information under the sections entitled: *"Fun In The Forest"; "Forests and Wildlife"* and *"A Vacation Guide."*

The student of history is bound to enjoy *"The History of Forestry in America"* and the article *"Since the Days of Leif Ericson."*

To the world-minded citizen, the eleven pages on *"The World Forest Situation"* would be of great interest.

The teacher and the public-relation minded person might take a professional interest in the section—*"Forester's Calling"* or such subjects as *"Teachers in Conservation"; "Education in Forestry."*

The great importance of Insects, Disease and Parasites is emphasized in the fact that nearly 75 pages are devoted to this phase of Forest Management. The stories of the elm diseases, the chestnut blight, white pine blister rust, etc., are well told by the men who helped combat them.

To the men working in the midwest, the article on *"Shade Trees for the Plains"* and the one on *"Windbreaks and Shelter Belts"* would be of great interest.

The reason we are usually interested in a subject is because we know something about it. It does not seem possible that anyone could have been reared in the United States without knowing something about trees. Therefore, you are probably posted on many of the topics mentioned, nevertheless, there are many fascinating new outlooks to be uncovered just by browsing through this volume.

If you have never visited a wilderness area, enjoy the adventure by proxy while reading *"Trail Riding in the Wilderness."*

If you are not familiar with preservative treatment of wood, here's your chance to learn something that is of growing importance to farmers and wood users all over the country. Even more significant is the fact that making wood last three times as long is conservation of a valued resource. Such articles as *"The Gluing of Wood"* might give you some ideas to use in your home shop. *"Pre-fabricated Houses"* could be of value if you're planning to build.

To those of an inquisitive mind, **"Trees"** is a gold mine of new topics.

I have just mentioned briefly a few of the 138 articles that are to be found. The editor says that there are some 11,350 publications about trees and forests in the Department of Agriculture Library. I think he and his staff and the numerous authors who contributed, are to be complimented on the grand job they have done in putting the essence of this vast library into one volume. There have been some omissions and a small amount of repetition but to my knowledge this book is the most complete on the subject that has ever been published. At a price of $2.00 from the Superintendent of Documents, or *"for free"* if your congressman has not yet exhausted his quota, you can hardly go wrong by owning this book.

—HOWARD MENDENHALL, *West Chester, Pa.*

THE STORY OF PLANTS. *By* JOHN ASCH. *G. P. Putnam's Sons, 1948. $5.00*

"The Story of Plants" by John Asch presents a modern and cosmopolitan viewpoint on vegetation. Much of the information was gathered during the author's travels in the United States and Europe. The text is profusely illustrated with appropriate black and white sketches.

There are 407 pages of scientific information written in easily readable style. The author says: "I have tried to present in this single volume a summary of the important features of plant life, described in non-technical language that a person with little or no knowledge of botany and related subjects can understand without consulting a glossary or dictionary."

The volume might well be called the omnibus book of plants. There is excellent treatment of basic fundamentals of morphology, physiology, genetics, ancient history, evolution and use of plants by man.

The last division, "Plants and Man," gives illuminating details about man's dependency on plants. Some of the statistics presented about the plants the human race uses are: 335,000 species of plants are known and about 2,300 of them are used by humans. About 1,000 are used for wood and wood products, 500 for food, 300 for drugs, 150 for condiments and perfumes, 85 for fibers, 75 for gums, resins and rubber, 65 for fats, oils and waxes, 60 for dyes, 55 for beverages, 20 for tannins, 15 for soaps and 10 for smoking and chewing.

Small, compact type reduces the readability of the book and is the only detracting feature.

—B. W. ALLRED, *Fort Worth, Texas*

MAKE FRIENDS WITH YOUR LAND. *By* LEONARD WISKENDEN. *The Devin-Adair Company, New York, 1949. Pp. 132. Price, $2.50.*

A book is known by the company it keeps. On the flyleaf of this book is listed *Pay Dirt,* by J. I. Rodale, *The Soil and Health,* by Albert Howard, and *Nutrition and The Soil,* by Lionel Picton. The foreword is written by Joseph W. Frazer, the founder of a company to produce organic compost on a "sizeable commercial scale".

The burden of the author is that of convincing the reader that "organiculture" is the answer to the ills of agriculture. Insecticides, fungicides, and fertilizers are credited with being accountable for our troubles. Sprays are said to be detrimental with the work of the fertilizing insects. They are not successful in curing the ills for which they are supposed to be the remedies.

Albert Howard and his colleagues are given the usual round of praise, while the entomologists, plant pathologists, and fertilizer advocates are ridiculed. The work of Waksman is held in high esteem because the author sees in Waksman's antibiotics the explanation which he seeks for superiority of organic manures.

In answer to the two main criticisms that have been leveled against compost farming, namely the cost of producing it and the inadequate quantities that could be made available for use, the author develops some interesting figures. Quoting Fried Sykes, an Englishman, on the cost of making compost, and translating this into United States terms, he arrives at a figure of $1.35 per ton, which is quite close to Pfeiffer's $1.40. He estimates the quantity that could be produced at 7,500 million tons per annum, or enough to supply about 20 tons per acre of farmed land. Of this, 20 per cent would be animal manure and the remainder would be derived from other organic wastes.

But the author, at the risk of falling from grace among his colleagues, advocates for city folks who may not be able to obtain manure an investigation into the possibilities of using chemical fertilizers as food for microorganisms. The bodies of these microorganisms would then be used as substitutes for manure. For this, however, he greatly favors the relatively insoluble forms of native or synthetic rocks, rather than the soluble fertilizer salts.

The book is well written and very interesting. It is technically sound, insofar as the author's use of chemical terms is involved. Most of the concepts have been presented equally well, however, by other authors. The last chapter gives some very useful instructions on the building of a compost heap.

In a critical examination of this book, the reviewer did not find much to criticize except the author's assumption that all the current ills of agriculture could be cured merely by changing from chemicals to composts. Most soil-plant specialists agree that our present methods of control of insects and diseases leave much to be desired. But great progress is being made in the development of selective organic chemicals for such purposes and in the breeding of resistant plants. It is also agreed that fertilizers are being substituted in too large part for long-time systems of soil management. The reviewer sees no reason to be seriously disturbed about chemical fertilizers, since the excellent results from their use, in terms of both quantity and quality of crops, speak for themselves. But there is need that more attention be paid to improved systems of land use that give more consideration to the use of sod crops and green manures. There is also great need to put more effort into the saving of manures and of all kinds of plant wastes and incorporating them into the soil.

The book is recommended for careful reading by those who produce and sell fertilizers and by those who make the heaviest use of them. The truth lies someplace between the concepts of the advocates of complete organiculture and those of the equally vociferous advocates of a complete chemiculture.

—FIRMAN E. BEAR, *New Brunswick, New Jersey.*

THE BUSINESS OF FARMING. *By* HERRELL DEGRAFF *and* LADD HAYSTEAD. *University of Oklahoma Press, Norman. 1948. 244 pp. Illus.*

The first chapter in this book is about soil management. It is significant that a discussion of farm economics should begin with the soil—especially one that is so frankly "commercial" as this one.

"The farming the writers are talking about is a serious, possibly even a cold, business proposition entered into with the primary intention of making a profit," the authors warn in their introduction. In this type of farming "The soil will make—or break—you!"

Their discussion of soil management is sound and realistic. It is conversant with modern trends and fads, with Edward Faulkner's *"Plowman's Folly"*, Louis Bromfield's *"Malabar Farm"*, and Max Crowder's *"Stubble-mulching"*. It is also conversant with the work of the agricultural experiment stations, the Soil Conservation Service, and soil conservation districts. They are presented in reasonable perspective.

As these authors see it, the other elemnts of succssful farming are equipment, labor, and management. These are discussed with equal skill and penetration. If the book does not give precise instructions on all the points to making money at farming, it does something that perhaps is better: it impresses a guiding attitude which should lead the capable manager to success.

—BEN OSBORN, *San Angelo, Texas.*

A NEW SYSTEM OF AGRICULTURE. *By* A. P. COLE. *Published by A. P. Cole, Wellsville, New York. 1889. Pages 103. Book out of print.*

This book is one of the earliest attempts to do something about soil erosion and water conservation. It was undertaken by A. N. Cole and written up by his son A. P. Cole in the year 1889. The author points out in the foreword—"a constant and increasing demand from every part of the world and especially sections of our own Country, for a cheap manual of Mr. Cole's system of Drainage and Irrigation has at last induced him to intrust to me the work of arranging this book, he being too ill at this time to do so."

A. N. Cole was born in Cattaraugus County, N. Y. in 1821. At the age of 11 he first read of the Chinese system of agriculture and the construction of terraces for the conservation of soil and water and the use of liquid manures. This system of farming made a deep impression on Mr. Cole and remained uppermost in his mind for many years.

The great drought of 1838 caused Mr. Cole to begin looking more deeply into the origin of springs, flow of rivers and streams, rainfall and runoff. This started him to thinking about some system of farming or some measures that could be installed on the land so that rainfall and melting snow water might be saved and stored for future use.

In 1882 Mr. Cole began quietly and unknown to anyone outside of his own family to construct his new system of Drainage and Irrigation. This system was the result of years of study, observations and experiments. A small plot was completed that year on his own farm. The following is a general description of the system as applied by Mr. Cole to his farm, "Home on the Hillside, Wellsville, Allegheny County, N. Y.":

"A trench, one yard wide and four feet deep and twelve rods long was opened up across the hillside. Two rods below this trench and parallel to it, another trench was constructed and so on down the slope. At the bottom of the trench was placed cobbles and blocky stone, until the trench was nearly half filled, then smaller stone were laid over these, finer stone then added, until a comparatively even surface resulted. Next came shingling with flat stone, two layers from end to end, breaking joints being required. Over these was placed a cover of sod, weeds, straw or best material to prevent fine earth from filling the crevices between the stone. The excavated soil from the dug trench was then spread over all, the clay being first returned to the trench. The remaining surface and subsoil was pulverized and admixed, all fine stone being raked out and the trench filled to a point slightly above the original ground level. This was done so when settled all should be even."

As these trenches were dug across the hillside, they were connected by an overflow or drainage trench, one at each end and one in the middle. These overflow trenches were 18 inches deep and water conducted down the hillside by either a stone trench or tile line. "This resulted in two water tables beneath the land surface, one of percolation from the bottom of reservoir trenches across the slope, and the other overflow trench and filtration in times of surfeit. This method resulted in reservoir trapping rainfall and melting snows, thus holding thousands of barrels of water in storage which would otherwise have been lost in wash or drainage, and at the same time so saturating subsoils as to convert them into store houses filled with moisture to be found at all times available for use in growth of vegetation."

Mr. Cole also describes how his system can be used on steeper land with bench terraces, flat lands and swampy lands. He explains how the system can be used for grassland farming, orchards, lawns, and market gardening plots. He tells how this system can be installed on sandy soils and on a clay soil as found on his farm described as stony clay soil, underlain by a hard pan situated on a hillside that was washed, gullied and cut up by rains and melting snows, wet and cold in the spring, and in the summer sunbaked into crusts and lumps.

The cost per acre for installation ranged from $30 per acre to $300 depending upon spacing, soil type, availability of labor and equipment.

On his own farm the increase in crop yields were very high. The former owner told how land that he had heavily manured and hand spaded only produced 60 bushels of potatoes to the acre. Under Cole's system this land produced over 1000 bushels of potatoes per acre. Yields of apples, sweet corn, raspberries, cabbage and timothy hay also were remarkable.

The book contains numerous testimonials as to size, color and yields of crops as viewed by various farmers and agriculturalists of that period. Also included are many editorials from leading newspapers and farm journals of that period explaining the system and its outstanding results. All recommended it to be adopted to increase production, reduce erosion and to make farming a more profitable business. In fact, one editorial recommended that some millionaire such as one of the Vanderbilts of that day come forward and put their money back of this system "whose successful working would confer upon the human family a greater benefit than any novelty or invention or discovery since the introduction of printing."

—H. J. RATH, *East Aurora, New York.*

OUTLINE OF THE MANAGEMENT OF FUR ANIMALS. *By* WARREN W. CHASE *and* ELIZABETH B. BEARD. *The Overbeck Co., Ann Arbor, Michigan, 1948. 46 pp., lithoprinted. $1.75.*

OUTLINE OF THE PRINCIPLES OF WILDLIFE MANAGEMENT. *Ibid. 1947. 61 pp. $1.75.*

Chase, formerly Regional Biologist for the Soil Conservation Service and now Professor of Wildlife Management at the University of Michigan, has collaborated with Elizabeth Beard in publishing a series of "Teaching Aids in Wildlife Management" (*Outline of Waterfowl Management*, 1947 $1.25, and *Outline of the Management of Upland Game Birds*, 1949, are additional titles).

Such published aids for the wildlife fields are rare and welcomed. Outside of the academic circle they should serve a usefulness in enabling "field men" the opportunity to score themselves in a systematical way in their knowledge of the subject matter, as well as to extend their education. In view of this extra-curricular value, the "aids" would have been greatly improved by having tables of contents and brief summaries of the fundamental principles. Not since Lee E. Yeager's excellent *A Contribution Toward a Bibliography On North American Fur Animals* (Illinois Natural History Survey, 1941, 209 pp. mimeographed) has there been a published compilation of fur animal literature. These "aids" used in conjunction with *Wildlife Review* (Fish and Wildlife Service, Laurel, Maryland) should encourage fieldmen and administrators to keep up on the literature and new advances in management of fur and other wildlife, even without access to well-stocked libraries.

Soil and water conservationists will find that Chase and Beard have not neglected the land and water aspects. In view of the present flurry of drainage and restoration of wet areas, the "aids" should have some usefulness in presenting the often overlooked values of wet areas in producing wildlife. The authors have by-passed certain "humanitarianism" aspects of fur trapping involving the use of live traps.

The study units within the "aids" generally follow a pattern of "Outline, Questions, References." The questions are an excellent test of the extent of one's mastery of the subject's contents. There are no drawings in either "aid". These "aids" should encourage other teachers of wildlife management to publish similar guides, especially whenever the teacher has a background in other phases of land and water use in addition to wildlife. Apparently Chase's experience in soil conservation has added depth and breadth to the treatment of the subject matter in these "teaching aids."

—DOUGLAS E. WADE, *Hanover, New Hampshire.*

FOREVER THE LAND. *By* RUSSELL *and* KATE LORD. *Harper and Brothers, New York. 1950.*

Russell Lord, who does the writing, and Kate Lord, who does the illustrations, describe their book as a country chronicle and anthology. It is all this and more. It could even be called "the conservationist's compendium and guide" for it misses very little if anything in this field. At first glance it is an auto-biographical sketch of the Lords' but shortly it plunges into the historical account of Friends of the Land and brings the organization's personnel and activities up to date. There follows in quick succession a series of anthologies, the first concerning persons and places including Ben Smith's deeply moving poem *"No Crown, Lord"*, Louis Bromfield's *"A Piece of Land"*, and a revealing story of Hugh Bennett by Jonathan Daniels. The second anthology is titled *"Perspectives"* and comprises four articles and a poem presented in the same words used to introduce Lord's former work *"To Hold This Soil"*. "The purpose here is to exhibit conditions and methods of defensive husbandry. But first . . . to stand off a while from the problem, erect a rough frame of time and space around it, and try to view it with some sense of proportion, removed from immediate alarums." Liberty Hyde Bailey's *"Marvels of the Earth"*, Edwin Hubbel's *"From Our Home On the Earth"*, James Retties' *"But A Wtach In the Night"*, John Collier's *"Keeping Faith"*, and Byron Herbert Reece's poem *"Gathers Again to Shining"*, are used here to give us this view from afar. Nothing I have ever read is better fitted for this pleasant task. *"Marvels of the Earth"* and *"But a Watch in the Night"* are particularly impressive, they draw the reader out of the immediate into the cosmos from a self-adopted importance of the here and now into an humble oneness with all time and all life.

Other anthologies follow; we are now getting the lights and shades, the details, though not too many details, *Forever the Land* never becomes the what to do dohow to do it-five acres and plenty-make every acre count type of book. There are no blueprints. Always it holds the mirror up to nature and the reader sees to the extent that he has vision to see.

"At Home on the Earth", a collection of nine personalized studies of man's relationship with the land, is followed by *"Measures of Husbandry"*, *"Parts of the Country"*, *"Other Lands"*, *"Views and Visits"*, and the final anthology called *"Songs"*. Roving in and among these dramatic selections one finds the author joyfully at work binding the widely separated literary fragments into a cohesive whole. This thread of autobiography and history called "Chronicles" is a bouncing account of the author's and his associates' efforts to birth Friends of the Land and to force into its tender body the makings

of a national organization capable of rousing the nation from its indifference to the losses of soil and of the life lost along with the soil. The high hopes, heavy speeches, lack of cash and other dramatic factors that invariably gather about volunteer organization work are deftly but feelingly told through these *"Chronicles"*. Unless blinded by my devotion to him I believe Lord emerges a greater figure than most of the others he sets out to "chronicle". Self-abnegation is the first law of good reporting and would naturally be expected of our author but we grew a little restive at times among the chronicles where on occasion wordy but ineffectual individuals were given the author's time and space. Russell Lord is better than he thinks he is and among the writers of the land and in the field of conservation there is no one who writes as well. His views are sound and his pen is crystal clear.

Well, what about this book called *"Forever The Land"*? I personally believe it's the best all-around book on the subject. I like it very much. It is inspiring, it is challenging, it is satisfying, at times it is profound. The author's belief in the cause and its eventual solution is contagious though you do not find it there in so many words. Russell Lord doesn't preach; he narrates, hints. As with Kate Lord's illustrations, the lesson is there for all to see. But the reader himself must see it.

I prefer his Introduction, the little masterpieces called *"Perspectives"* and the *"Measures of Husbandry"*. The whole book is good reading. None of it is tiresome reading. Someone said that if you read one good book, sentence by sentence, word by word, letter by letter, you will forever afterward, to some extent, be an educated man. I would say that if we treat *Forever the Land* in this manner we will not only become educated people to some extent but we will become without question a dyed-in-the-wool conservationist and a true friend of the land.

Its' a book to be read, owned, and re-read.

—CHANNING COPE, *Atlanta, Georgia.*

Soil Erosion in the High Country of the South Island *by* H. S. GIBBS *et al. Bull. No. 92 (Soil Survey Publ. 10) Dept. Sci. and Industrial Research, New Zealand. 72 pp. illus. 3 folded erosion and soil maps. 1945. 72 pp. 5s.*

This neatly organized and attractively published bulletin of the Government of New Zealand adds to the growing erosion literature of that country. There are several excellent photographs and three colored maps of erosion in the South Island. There is tabular material on erosion and a bibliography. The American soil conservationist will find interesting parallels as well as extreme differences between what we know here and the bulletin's description of types of erosion, burning, grazing, and revegetation. Soils and vegetation types are described.

Science and Erosion Problems in the Middle East. *By* HUGO BOYKO, *Ecologist to the Government of Israel.*

This 22-page paper was published in *The Journal of the Middle East Society*, Vol. 1, No. 3-4, 1947, P. O. Box 7050, Jerusalem. The author emphasizes non-experimental methods of recognizing erosion, as (a) old trees as indicators, (b) compensation angle of erosion, (c) fossil sand dunes and antique debris-heaps, (d) archaeological remains. There is a short bibliography. The paper is of particular interest to Americans because of the dearth of erosion literature from the eastern Mediterranean area.

A Study of the Ecology and Economic Value of Crop Field Borders. *By* CHARLES ARTHUR DAMBACH. *Ohio State University Press, Columbus, Ohio. Graduate School Studies, Biol. Sci. Ser. No. 2, 205 pp. 1948. $3.50.*

This paper-bound volume presents a thoroughly scientific evaluation of the insects and vertebrate animals existing in herbaceous and woody vegetation on the margins of cultivated fields in Montgomery County, Ohio. The study is the result of six years' collecting and analysis, and is based on Dambach's doctorate thesis, which was to determine to what extent field border management for conservation purposes contributed to crop pest problems. More than half the volume consists of tabular material, graphs, and photographs supporting the results. The conclusions point to moisture conservation by border plants through control of wind velocity, crop yields reduced in proportion to height of border vegetation, support of beneficial as well as injurious species of wild animals, and damage to crops in proportion to the botanical similarity between crops and border vegetation. The author concludes: In general, it appears that less crop pest risk is involved in the use of woody field border vegetation where the predominant crops are grain and forage plants; the converse is probably true with respect to truck and orchard crops.

The Way to Game Abundance. *By* WALLACE B. GRANGE. *Charles Scribner's Sons, 597 Fifth Avenue, New York. 365 pages. 1949. $6.00.*

This is an important book and should be of interest to wildlife technicians—especially because of the small-game cycle theory advanced by the author and based on his own personal experiences and research not published elsewhere. In addition, the book also discusses the basic needs of wildlife including the improvement of habitat management and other related factors.

An excellent discussion covering small game—snowshoe rabbits, grouse, white-tailed deer and others—is an important part of the book. This section contains ma-

terial found only in technical journals and is presented in language that the average hunter can understand.

A Conservation Handbook. *By* S. H. Ordway, Jr. *The Conservation Foundation, 30 E. 40th Street, New York 16. 76 pages. 1949. $1.00.*

Mr. Ordway points out in the preface of this very fine handbook that it "seeks to present in simple definition the more important terms, concepts and practices used in conservation of renewable resources." The definitions cover all phases of land, forest, range, water and wildlife management. State and National Parks, Monuments and Wilderness Areas are also included.

The handbook has wide application because of its simplicity and clarity. Conservationists will want to add it to their libraries for reference purposes. Others will find it extremely helpful in properly interpreting and understanding the conservation movement.

Crop-Use Research

(*Continued from page* 10)

We may have to find out how to grow certain new crops to meet industrial needs, as well as how to grow some of our old crops more economically. It is an interesting fact that there are more than 300,000 known species of plants growing in the world. But of this large number less than one percent—that is, fewer than 3,000 plant species—are now cultivated. The vast majority of the thousands of uncultivated species have not even been analyzed chemically to find out what valuable components they may contain. The Bureau of Agricultural and Industrial Chemistry now has under consideration a project for analysis of some of the wild plants of this country to determine their potentalities for cultivation.

To the problem of producing enough food for an often hungry world we may have to add the problem of growing sufficient proteins, starches, fats and oils, and other substances to feed an increasing number of industrial operations dependent upon these materials. So far as food production is concerned, a wise and forward-looking policy of soil conservation may also seek to promote more efficient use of the nutritive elements of agricultural commodities, by techniques of food preservation and by other means.

I do not know how these considerations may affect the philosophy and practice of soil conservation, but it does seem reasonable to suppose that they may have some impact. I have presented them to you with the thought that in a general discussion of conservation, such as that undertaken at this meeting of your Society, we might profit by some consideration of the changing and expanding picture of crop utilization.

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FIELD NOTES AND COMMENTS

Society is Contributing to "Conservation Movement"

Dear Mr. Watson:

I was tremendously interested in the proceedings and program of the Society at St. Louis, attempting to observe and draw some conclusions about what contribution that Society is making to the "Conservation Movement". Your report on the classification of members gave me the idea that it might be possible to almost quantify or make an index to measure the movement.

Some movements are started by technicians and scientists but sooner or later the publicists and the public in general get concerned. In the end, or as time goes on, a thing becomes a movement when it has a quite diverse gamut of persons all singing the same theme song.

At St. Louis you had the soil conservation technicians, scientists from the University, publicists, both book writers and newspaper men, private industry and some of the general public in attendance and on the program. It was only by observing the part that each of these played on the program and conversing with them in the lobby that I could size up the situation, until you made your report on classification of members.

I have no doubt you will continue to report from year to year this classification of members and thus one will be able to see who is in the conservation movement, so far as the Society reflects the movement. I am wondering if you would be able to classify the membership for past years. I am wondering also if you might be interested in thinking through how your classification could reflect classes of people such as I have mentioned.

—Carl C. Taylor, *Bureau of Agricultural Economics, Washington, D. C.*

Blue Lupine Spreading

Green weight yields of more than 10,000 pounds per acre by the middle of February are not unusual for blue lupine, a soil-conserving winter legume cover crop which has spread with amazing rapidity through the lower Southeast during the past 10 years. The Soil Conservation Service estimates that more than a half-million acres of blue lupine were planted in the fall of 1939 in the states of Georgia, Florida, Alabama, and South Carolina.

Blue lupine proved to be especially valuable as a winter cover crop following peanuts on the greatly expanded acreage from which peanuts were harvested during the war. (Figure 1). The volume of seed harvested and the acreage planted to blue lupine has continued to increase rapidly since the war. The Bureau of Agricultural Economics estimated seed production in Georgia, Alabama, Florida, and South Carolina in 1949 at 53,800,000 pounds. In Georgia alone, blue lupine seed production in 1949 was estimated at 36,800,000 pounds.

Fifty pounds of seed per acre when planted before the middle of October usually gives a fair stand that covers the ground well in the late spring and makes a large crop of seed. Farmers who produce their own seed often plant 75 to 100 pounds per acre, which gives a thicker stand and earlier ground cover. At 100 pounds per acre, the seed harvested in the four states in 1949 would plant 538,000 acres and at the 50 pounds per acre rate more than 1,000,000 acres.

Except for the relatively small acreage harvested for seed (estimated at 56,000 acres in 1949), virtually the entire acreage is turned under for soil improvement, because blue lupine is unpalatable to livestock. Other palatable strains of lupine have been devloped, but have not been used widely in the Southeast. It is estimated that corn yields are increased from 5 to 20 bushels an acre when corn is planted following blue lupine turned under for soil improvement.

—T. S. Buie, *Spartanburg, S. C.*

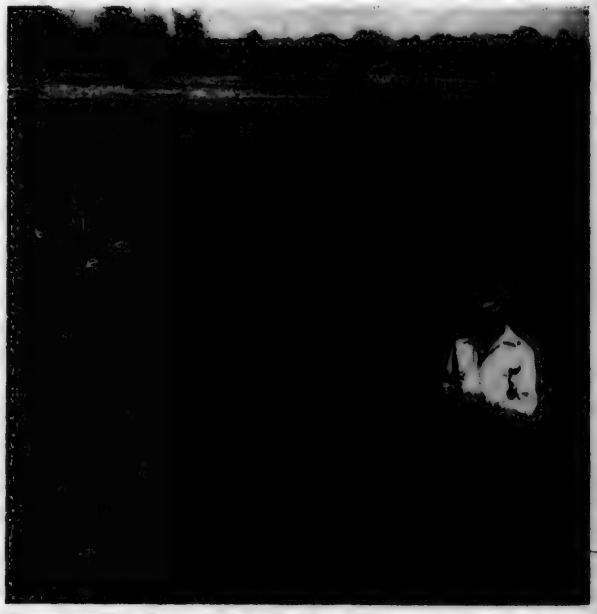

Figure 1. Blue lupine is a valuable soil conserving winter cover crop and its use is spreading rapidly through the lower Southeast.

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● Here is the latest J. I. Case Co. contribution toward better handling of run-off water. This new 10-minute film and a take-home booklet now released describe and picture the construction and operation of an actual water-spreading system in use on a farm in the Great Plains.

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CASE

Grasses Play Leading Role in Soil Conservation Work

The genus wheatgrasses (*Agropyron species*) comprises a group of sod and bunch, native and introduced grasses, that are highly versatile in use and adaptation. Besides being palatable and hardy, these grasses lend themselves to seed increase and stand establishment with ordinary farm equipment. Because of these excellent characteristics, the wheat grasses are now playing leading roles in conservation work on the Great Plains. Pictured and described below are four of the most important species.

Crested wheatgrass (*Agropyron cristatum*), a perennial bunchgrass (Fig. 1), was introduced in 1898 from Siberia wheer it is native to cold dry plains. It was some 20 years later before its ability to withstand extremes in temperature and drought was recognized in this country and now this grass is established on more acres than any other cultivated species in the Northern Great Plains. It is long-lived and adapted to a wide range of soil types. The high quality hay and pasture produced is palatable to all classes of livestock. Because this grass starts growth early in the spring and with moisture greens up again in the fall it is an ideal supplement to native ranges in the spring wheat region. Crested wheatgrass protects itself from drought injury by becoming dormant in adverse periods and during the hot dry months of summer. This grass is a good seed producer, and seed is available in commercial channels. By virtue of its hardiness and its tough extensive root system, this species is outstanding in control of both wind and water erosion.

Tall wheatgrass (*Agropyron elongatum*), a perennial bunchgrass, was introduced in the United States during the early 1930's from the Black Sea area of Turkey where it is native to low marshy sites. This erect, tall-growing grass furnishes an abundance of forage and is a particularly good seed producer. Its palatability is not quite as high as that of crested or intermediate wheatgrass, but this is offset by high production and especially by the long growing season. Tall wheatgrass, like the others, starts growth early in the spring, but, unlike the others, maturity is late and this grass continues growing well past mid-summer. Another characteristic important to utilization in the Great Plains Region is that of alkali and wet-soil tolerance. Because of this tolerance, tall wheatgrass is being used for pasture and hay on land previously removed from a production status due to irrigation seepage, high water table, or wet alkaline conditions.

Intermediate wheatgrass (*Agropyron intermedium*), is also a recent immigrant to our country and one that has been popularly accepted. This sod forming perennial came from south Russia in 1932. Soil Conservation Service Nurseries in Region Five starting with a handful of seed in 1937 increased and promoted this grass to the point where commercial seed houses are handling a large part of the million or more pounds of seed now produced annually. Intermediate wheatgrass is adapted to many soils and conditions, but for optimum growth needs adequate moisture and fertility. It is more drought resistant than smooth bromegrass. Advantages of this grass include good seeding habits, high seedling vigor, and ability to recover quickly after cutting or grazing. Its very palatable spring and fall growth make it much in demand for pasture plantings. Quick germination and the tough sod produced encourages use in waterways and terrace outlets.

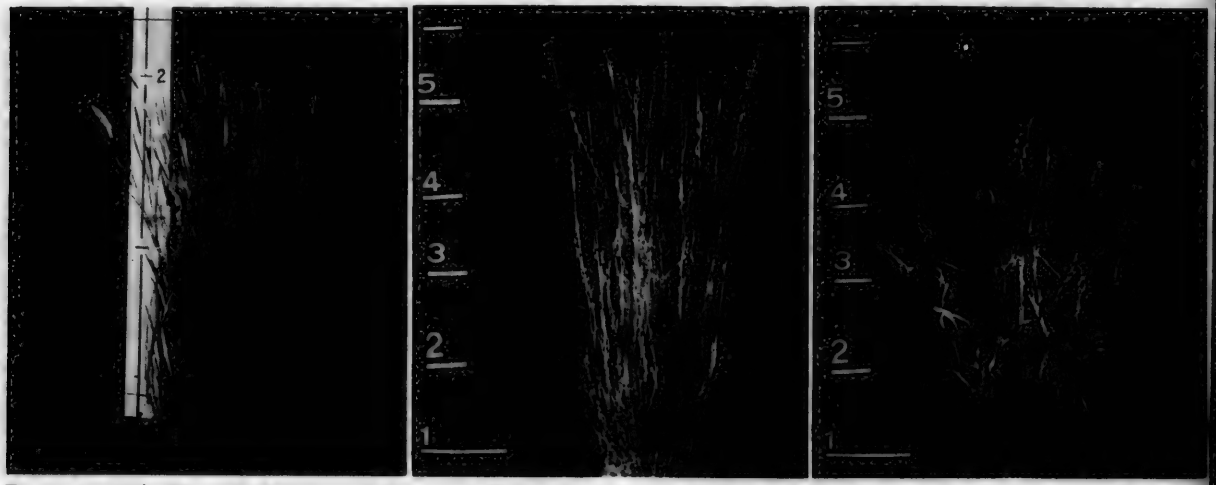

Figure 1. *Left,* Crested wheatgrass (*Agropyron Cristatum*). *Center,* Tall wheatgrass (*Agropyron Elongatum*). *Right,* Intermediate wheatgrass (*Agropyron Intermedium*).

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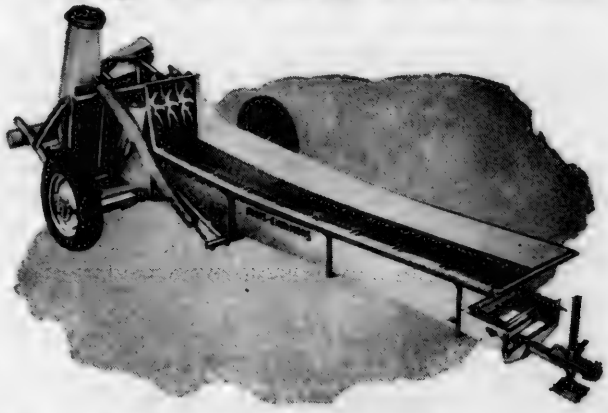

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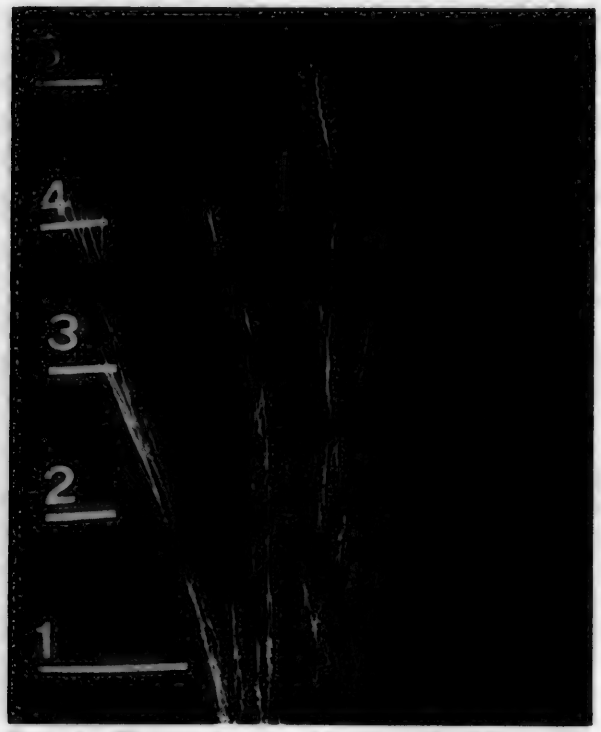

Figure 2. Western wheatgrass (*Agropyron Smithii*) is native to the plains.

Western wheatgrass (*Agropyron smithii*), is as native to the plains as were the Sioux Indians. It is a sod producing long-lived grass that continues to be one of the principal species in the vast ranges of Nebraska, Wyoming, Montana, and the Dakotas. Although widely adapted, it is most at home on heavy soils where surface runoff is concentrated. Characteristics include a high degree of drought and cold hardiness. Growth starts fairly early in the spring and palatable forage is produced until hot dry weather gives the leaves a coarse quality. Western wheatgrass is a heavy seeder in years when proper conditions are present. Some difficulty is encountered in obtaining stands through reseeding because of a slowness in germination. Once established, however, the natural vigor of the grass and its ability to form a dense tough sod make it an important species for waterways, terrace outlets, and in range revegetation.

—LAIRD G. WOLFE, *Waterloo, Nebraska*

Recent Research Reviews

(*Continued from page* 33)

A diversion trerrace was constructed above one of the principal gully systems to carry off the water which had been flowing into the gullies. The individual gullies in this system then received different treatments. All of the practices used were more effective in this area, from which the water had been diverted, than in the other gully system areas.

When the area was resurveyed after six years, it was found that all of the treated gullies were stabilized. The individual gullies which had been left untreated, as checks, were still active. Vegetative methods, where adapted, were found very effective in controlling gullies. Dams are temporary in nature. They proved useful in holding the area until vegetative measures became effective. Loose rock dams proved quite desirable because of the availability of the material in the region.

Construction of Farm Fish Ponds. *By* J. M. LAWRENCE; *Ala. Agr. Exp. Sta. Cir. No. 95, June, 1949.*

The author discusses the size and type of drainage area for a pond; water supply; type of soil necessary to hold water; design of the dam, pond drain and spillway; and construction methods developed for building a pond. The discussion is based on studies conducted for the past 15 years during which time 137 ponds were constructed for use in fish production research.

Application of Flood-Storage Accounting Methods. *By* C. O. CLARK; *Transactions, American Geophysical Union, Vol. 30, No. 4, pp. 528-532, August, 1949.*

This paper discusses day-to-day application of the author's method of flood-storage accounting as used in flood-forecasting studies on the Roanoke River above Buggs Island Dam Site in Virginia. Use is made of data from six telemark installations at river gages above the Dam Site. This method has been used to predict successfully the flood rises on the Roanoke River.

A Manometric Settling Velocity Tube. *By* MARTIN A. MASON; *Transactions, American Geophysical Union, Vol. 30, No. 4. 533-538, August, 1949.*

A theory is developed for a manometric settling velocity tube which permits rapid, accurate determination of still-water settling velocities of sediments in the sand-size range. A preliminary design of apparatus is discussed.

Computing Soil Temperatures. *By* WALTER B. LANGBEIN; *Transactions, American Geophysical Union, Vol. 30, No. 4, pp. 543-547, August, 1949.*

This paper develops a method for computing temperatures at a point in a soil from surface temperatures. The method is adaptable to the irregular fluctuations in temperature ordinarily found in nature as well as to ideal cases. The temperature at a point in the soil is expressed as a weighted function of antecedent temperatures at the surface. An analogy is made with the unit hydrograph, a familiar tool in hydrologic practice.

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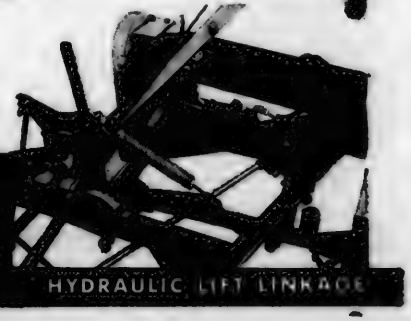

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George Mercer Award Won By Dyksterhuis

His monograph on the vegetation of the Western Cross Timbers of Texas has won for Dr. E. J. Dyksterhuis, Lincoln, Nebraska, the 1949 George Mercer Award of the Ecological Society of America, it was announced at the joint meeting of the Society with the American Society for the Advancement of Science in New York in December.

The winning paper was published in the July 1948 issue of ECOLOGICAL MONOGRAPHS. It presents a quantative analysis of the vegetation of an important natural area in relation to grazing. A system of classifying range condition, first presented here was elaborated in a later paper in the JOURNAL OF RANGE MANAGEMENT for July 1949.

Dr. Dyksterhuis is Chief of the Regional Range Division, Northern Great Plains Region, Soil Conservation Service, at Lincoln. At the time the paper was published, he was a zone conservationist dealing with range problems in the Western Gulf Region with headquarters at Fort Worth, Texas.

Conservation Leaders Meet in New York

Leaders representing the Soil Conservation Society of America, American Forestry Association, the Conservation Foundation, Wildlife Management Institute, Friends of the Land and the Association of Soil Conservation District Supervisors met in New York City early in January to discuss the development of "A Platform for Organizations Favorable to Scientific Conservation of Land and Water Resources." The Platform, when completed and released, will include the basic principles upon which a scientific conservation program should be predicated. Dr. Firman E. Bear, President of the Soil Conservation Society of America, was named Chairman of the group.

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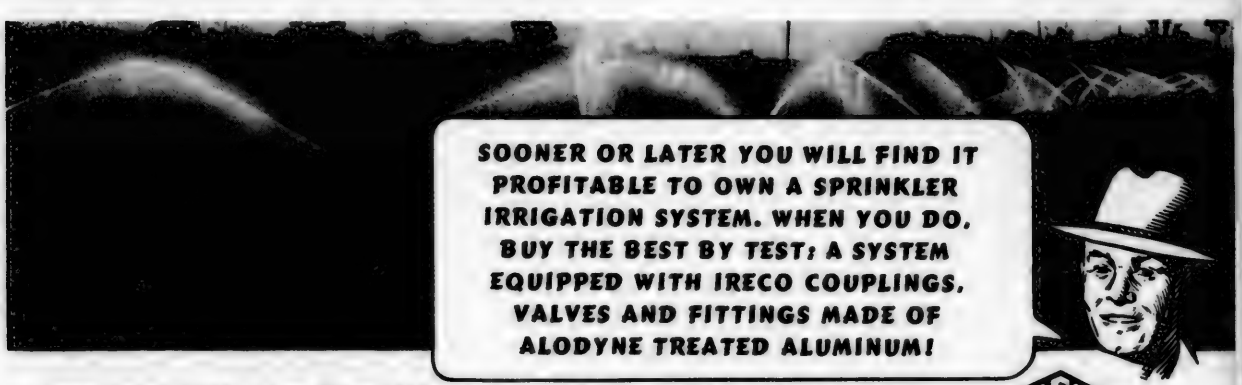
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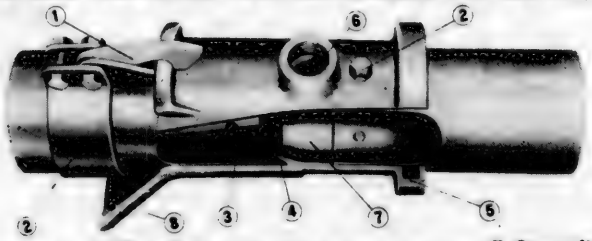

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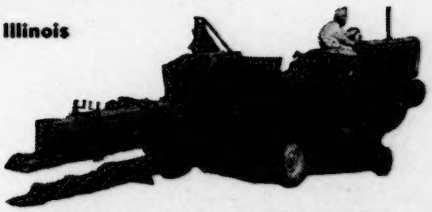

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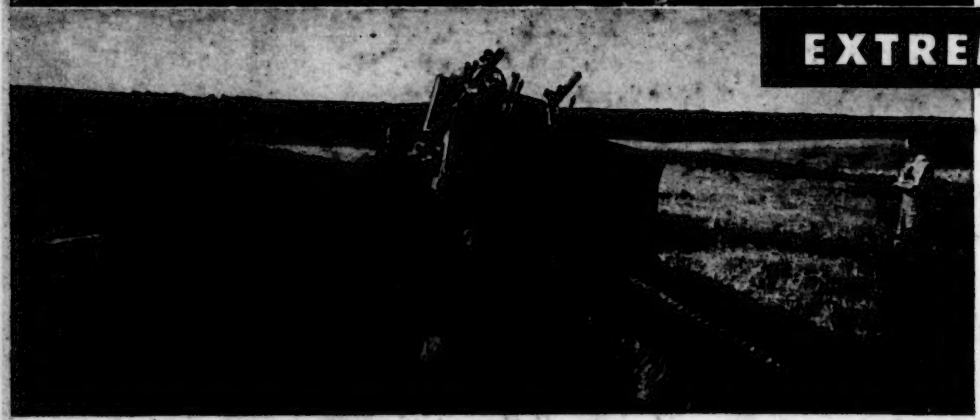

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